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ECOLOGICAL SURVEY OF THE PROPOSED TIMBERED CRATER RESEARCH NATURAL AREA LASSEN NATIONAL FOREST, SISKIYOU COUNTY, CALIFORNIA

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INTRODUCTION

The Timbered Crater candidate Research Natural Areas (TCRNA) is on the Hat Creek Ranger District of the Lassen National Forest. The area was selected and nominated by the Lassen National Forest as a candidate RNA in 1982 to preserve an example of the Baker (Modoc) cypress (*Cupressus bakeri*)[1] target element for the Modoc Plateau Province. In May 1989, the area was also determined to be suitable for representation of the northern basalt flow vernal pool target element following a suggested addition of two vernal pools about 0.5 to 1 mile (0.8-1.6 km) north of the originally proposed boundary (Richard Henry, Lassen Forest Supervisor May 1, 1989 *in litt.*). These pools are currently included in the proposed Adobe Vernal Pools Botanical Special Interest Area (Draft Lassen National Forest Land and Resource Management Plan, 1989).

The TCRNA as defined in this report covers 1777 acres (719 ha) including all of secs. 23 and 14 and portions of the southern halves of secs. 11 and 12 T39N, R4E Mt Diablo Meridian (see map 2). The boundaries differ from those originally proposed by the forest (see map 3). The approximate center of the proposed RNA is 41° 13' N, 121° 28' W. In addition to this area the Bureau of Land Management (BLM) administers a 1448 acre (586 ha) Research Natural Area for Baker cypress and lava rock on adjacent lands to the east (see map 3). It has been suggested (Connie Millar PSW RNA committee, Gary Schoolcraft BLM Botanist, pers. comm. 1989) that management of the two areas be coordinated between the Forest Service and the BLM.

The overall topographic relief is low, with elevations ranging from 3520-3600 ft. (1073-1097 m). However, due to the recent lava flows over much of the area, the micro-topography is frequently rugged.

Access (reference maps 1 and 2):
The TCRNA is accessible from several points via Forest Service dirt roads. The following narrative describes entry counter-clockwise from east to west.

From MacArthur on State Highway 299 drive approximately 5 miles (8 km) east to the junction with the Day Road (county road 0S001). Drive 10 miles

[1] all scientific names of plants in this report are in accordance with Munz (1968) except for recent revisions which are in accordance with Smith and Berg (1988).

(16 km) N to the small berg of Day and continue approximately 3 miles (4.8 km) northwest to the junction of Forest Road 40N01. This road is gated, but the gate is unlocked in the spring and is passible with high-clearance 2- or 4-wheel drive. Continue on road 40N01 for approximately 2 miles (3.2 km) to the junction with 39N02 just south of Gassaway Reservoir. This unmaintained jeep road enters the RNA after approximately 0.5 miles (0.8 km). Although it becomes impassible after about 1 mile (1.6 km), it provides foot access to the core of the RNA and adjacent portions of the BLM RNA in secs. 13, 24, and 23 T39N, R4E. Re-tracing back to road 40N01 continue northwest approximately 0.5 miles (0.8 km) to the junction with road 40N19.2 Drive west on 40N19.2 approximately 2.2 miles (3.5 km) until the first large, meadowy vernal pool comes into view through the pine forest on the south of the road. This vernal pool marks the northwestern corner of the RNA. Driving time on this route to the northern vernal pool is approximately 1 hour from MacArthur.

Continue west past the northern vernal pool on 40N19.2 approximately 1.5 miles (2.4 km). Make the first turn east on an unnumbered spur which travels east approximately 0.7 miles (1.1 km) to the northern edge of the second (southern) vernal pool midway along the western edge of sec. 14 T39N, R4E. Re-tracing this spur back to 41N19.2 continue southwest approximately 0.2 miles (0.3 km) and turn south on the well maintained, graveled 40N04.1. Follow this road south approximately 3 miles (5 km) to the junction with 39N04 and turn east. Follow this rough road approximately 1.8 miles (2.9 km) to the junction with road 39N02 and turn north. Follow this road to the edge of the RNA approximately 0.5 miles (0.8 km). In May 1989 this track was blocked by a large fallen snag at the approximate edge of the RNA. This is the same jeep trail discussed in the previous paragraph. It travels northeast across the area and connects with road 40N01 just south of Gassaway Reservoir.

Re-tracing back to the graveled road 40N04.1, travel south approximately 8 miles (12.8 km) through Horrs Four Corners (see map 1) to the junction with county road 9R01B. This paved road leads across agricultural land in Fall River Valley to Fall River Mills (the location of the Hat Creek Ranger Station) along state Highway 299 in approximately 9 miles (14.5 km). Travel time to the northern vernal pool via the latter route from Fall River Mills is about 45 minutes.

Foot travel within the RNA is complicated by the numerous raised, jagged lava flows. The best access route is the previously mentioned jeep trail 39N02. In general, the Forest Service land is less rugged than the BLM land to the east in secs. 13 and 24. Much of the western side of sec. 14 is composed of older, more heavily weathered lava and is relatively easy to traverse. The most rugged lava outcrops in the RNA occur in the southeast 1/4 of sec. 23. There travel is slow and tedious.

PRINCIPAL DISTINGUISHING FEATURES

The TCRNA has been nominated to represent the Baker cypress and northern basalt flow vernal pool target elements for the Modoc Plateau physiographic province. The Baker cypress stands at TCRNA represent a portion of the largest population of this species in the world, covering over 7000 acres (2833 ha). A map of the entire population is given in Stone (1965). The Timbered Crater population is also the type locality for Baker cypress, collected first by Milo S. Baker in 1898 and described by Jepson in 1909 (Griffin and Critchfield 1976, Stone 1965, Wolf 1948). Baker cypress is notable as the most cold-hearty of the cypresses (Peattie 1953, Keeler-Wolf 1985, 1989) and populations of this species are known from higher elevations, more interior locations (continental climate), and are subject to greater snowfall than any other species in California and perhaps the world (op. cit.). The Baker Cypress at Timbered Crater is largely restricted to the rough, lightly weathered surface of a series of recent lava flows some of which have emanated from Brushy Butte about 1.5 miles (2.4 km) to the southeast of the RNA and others from the Medicine Lake Highlands 25-30 miles (40-48 km) to the north.

The two vernal pools in the northwestern part of the area occupy a vastly different environment from the cypress-studded lava beds. These pools are also underlain by volcanic soil. However, this soil is older than the recent flows and is highly weathered into a deep clay-loam. This soil impedes drainage and causes large standing pools of water up to two feet (61 cm) deep to remain through several months of spring and into early summer in most years. The vegetation of the pools is dominated by hydrophilic annual and perennial herbs including several species either rare or representing northern population outposts here. The TCRNA is the only candidate RNA in the California Region selected to represent this unique vernal pool habitat.

In addition to the two target elements, the area also contains extensive

stands of interior (eastside) ponderosa pine (*Pinus ponderosa*) forest, well developed knobcone pine (*Pinus attenuata*) forest, and small semi-permanent rocky pools of water surrounded by lava, a unique aquatic habitat.

JUSTIFICATIONS FOR ESTABLISHMENT

Baker Cypress:
This candidate RNA is one of two chosen to represent the Baker cypress target element in the PSW RNA system. The other is the recently established Mud Lake RNA on the Plumas National Forest. Mud Lake is notable for its two small, but high elevation stands of Baker Cypress totaling about 160 acres (65 ha). These stands occur on moderate to steep slopes in high snowfall areas between 6200 and 6900 ft. (1980-2104 m) (Keeler-Wolf 1989). The isolation (ca. 76 miles or 122 km to nearest stands), and high elevation of the Mud Lake cypress has likely resulted in some genetic differentiation from the cypress of Timbered Crater (and other populations) even though both are currently classified as the same subspecies (Griffin and Critchfield 1976, and Connie Millar pers. comm. 1990).

The Baker cypress stands at Timbered Crater sprawl over thousands of acres of broken lava flows which recently filled the bottom of a broad structural valley in the southwestern part of the Modoc Plateau. Elevation is only about half as high as the highest Mud Lake stands and rainfall is about half the 40 inches (1016 mm) estimated for Mud Lake. The recent lava is porous and extremely well drained. As their shallow root systems rarely penetrate to the base of the lava flows, most cypress at TCRNA are probably under much higher moisture-stress through the growing season than those at Mud Lake. The different climate and substrate have undoubtedly influenced the genetic and physical characteristics of the local stands. The resin pits on the leaf scales of Timbered Crater trees are more distinct and result in a "grayer" look than those at Mud Lake. This may be a response to the drier, harsher climate (see Keeler-Wolf 1985) at Timbered Crater. In addition, the terpines in the foliage seem more aromatic in the Timbered Crater than the Mud Lake individuals. Connie Millar (PSW Geneticist, pers. comm 1990) is currently studying the populations of Baker cypress for genetic differences and suggests that variation among the Mud Lake, Timbered Crater, and stands in the Siskiyou Mtns. and elsewhere is ~~be~~ substantial.

The typical cypress trees at TCRNA occur as dense stands overlying a matrix of sclerophyllous shrubs, or as a sub-canopy strata in knobcone pine (*Pinus attenuata*) forest. They are rarely over 9 in (23 cm) dbh and 35 ft (11 m) tall. Conversely, the largest Baker cypress known (56 in, 142 cm dbh and up to 93 ft, 28 m tall) occur at Mud Lake RNA within an open to dense coniferous forest dominated by white and red fir (*Abies concolor, A. magnifica*).

Unlike the stands at Mud Lake, portions of those at Timbered Crater have recently been subjected to fire. Fire is essential to the successful reproduction and establishment of Baker Cypress (Vogl et al. 1977, Keeler-Wolf 1989), and the southern portion of sec. 25 and 26 on BLM land was burned in 1977, resulting in abundant reproduction of cypress in much of this area. The remainder of the cypress, including all on Forest Service land, is dominated by even-aged stands which date back to a fire or fires ca 1860. There are rare older trees, including individuals up to 24.5 in (62.2 cm) dbh and 70 ft (21 m) tall.

Vernal Pools:

The two pools at the northwestern corner of the RNA are both fairly large (ca 10-20 acres, 4-8 ha) and complex. They occupy shallow depressions surrounded by raised basalt flows. Each pool area can be divided into sections with different physical attributes. Each has a large main pool where water remains the longest, backed closely on one side by a recent lava flow and bordered on the other by an extensive flat rising gradually to raised volcanic uplands, much older than the flow on the opposite side. The central core of these pools tends to have scattered basaltic rocks and boulders while the surrounding flats are without surface rocks. Both pools have been lightly modified by cattle ranchers in the past with small excavated depressions (pit reservoirs) at each site and some evidence of vehicular travel. However, presently both areas are ungrazed (and have been for several years) and exhibit a diverse flora and fauna of vernal pool adapted species.

Notable among the plants associated with the area's vernal pools are four species listed by the California Native Plant Society (Smith and Berg 1988) as rare or endangered. These are *Orcuttia tenuis* (CNPS list 1b, a plant of highest priority), *Eryngium mathiasiae* (CNPS list 4, a plant of limited distribution), *Cuscuta howelliana* (CNPS list 4), and *Thermopsis*

macrophylla var. *argentata* (CNPS list 4). The first two speices on this list are also listed as sensitive by Lassen National Forest. In addition to these rare species a number of more common vernal pool endemics occur at each pool. These include three species of *Downingia, Pogogyne zizyphoroides, Machaerocarpus californicus, Psilocarphus brevissimus, Myosurus minimus, Mimulus tricolor, Navarretia minima, Gratiola ebracteata, Claytonia dichotoma, Orthocarpus campestris, Lythrum hyssopifolia, Plagiobothrys bracteatus, Polygonum douglasii* var. *johnstonii, Eryngium alismaefolium* , among others.

The vernal pool habitat at TCRNA is different from typical vernal pools of the Sacramento and San Joaquin Valleys and surrounding foothills. It is at a substantially higher elevation than typical valley pools, is underlain by volcanic substrate instead of sedimentary rocks, and is surrounded by coniferous forest and woodland as opposed to valley grassland and foothill woodland associations. The northerly and high elevation status of the TCRNA pools distinguishes them as being the highest elevation sites (Munz 1968) for such species as *Mimulus tricolor* and *Psilocarphus brevissimus* and the northernmost localities for species such as *Orcuttia tenuis, Grindelia camporum,* and *Orthocarpus campestris* (see Corbin and Schoolcraft 1989). Some relatively northerly vernal pool taxa (e.g. *Claytonia dichotoma, Eryngium mathiasiae, Navarretia minima*) are also near their southerly or lower elevation distribution limits at these pools . Other species associated with the pools, such as *Erigeron eatonii* ssp. *plantigineus* (see photo 4) are near their most western and lowest elevation limits in this vicinity. Regular lengthy freezes in the winter and ice on the pools in the early spring create different environments for the plants than typical low elevation vernal pools of cismontane California.

Holland's (1986) community classification for California vernal pools indicates that the TCRNA pools correspond most closely to northern basalt flow vernal pools. This category includes pools scattered on basalt flows in the lower foothills of the Sierra and Cascade Ranges. As described by Holland, these pools typically occur in small depressions (usually covering under 538 ft^2, 50 m^2) atop massive basalt flows. However, those of the Modoc Plateau may be substantially larger, including such very large vernal pools as Egg Lake (ca 12 miles, 19 km, northeast of the TCRNA) that cover several square km. In addition, there are several species of plants endemic to vernal pools of the Modoc Plateau not characteristic of the small foothill pools (including such species as *Polygonum minimum* ssp. *esotericum,*

Mimulus pygmaeus, *Eryngium mathiasiae*, and *Navarretia minima*), and several other more widespread northerly species which are not characteristic of the more southerly, low elevation basalt flow pools. This suggests that with further research it may be reasonable to differentiate the Modoc Plateau pools as a distinct community type.

Although a thorough survey of the invertebrate and vertebrate fauna of the pools was not made, cursory exploration uncovered such characteristic vernal pool species as long-toed salamander larvae (*Ambystoma macrodactylum*), Pacific treefrogs (*Hyla regilla*), western toads (*Bufo boreas*) as well as several species of aquatic insects (dragon and damselfly larvae, caddisfly larvae, and several aquatic beetles and true bugs). Three species of waterfowl and two shorebirds were also found in association with the pools (see appendix 2). Clearly the vernal pools at TCRNA are a distinct and relatively diverse ecosystem which is not currently represented in any other RNA in the Region.

Knobcone Pine:
The reconnaissance report for the TCRNA (McDonald and Rowe 1983) strongly recommends the area as a joint knobcone pine/Baker cypress RNA. This is despite the fact that the Mayfield cRNA several miles to the north had already been nominated as a knobcone pine target. According to McDonald and Rowe, the TCRNA has a knobcone component that is more representative of the species typical density and stand structure than at Mayfield. They suggest that overall the knobcone pine component is more vigorous and healthy than at Mayfield and state that a more ideal representation of knobcone pine structure and density is hard to imagine. Having not seen Mayfield, this writer can only comment on the knobcone pine at TCRNA.

In general, the knobcone pine stands are more restricted than the cypress, occupying the eastern central portion of sec 23 and most of sec 24 (BLM land, see map 5- vegetation map). However, in this area they tend to dominate, forming an open to closed (albeit spindly) canopy over the cypress and shrub vegetation. The best developed stands of knobcone pine occur in hummocky areas where numerous sinuous lava ridges interfinger with small inter-flow depressions or sinkholes formed by collapsed lava tubes (photo 1). Although the pines may occur atop the ridges, they reach their greatest dimensions in the depressions with a relatively deep accumulation of soil

and higher moisture availability. There they may be up to 2 ft dbh (61 cm) and 80 ft (24 m) tall. The average size for knobcone pines is about 9 in (23 cm) dbh and 50 ft (15 m) tall. There is substantial variation in size of knobcones from spindly individuals 2 in. (5 cm) dbh up to the largest hollow-inhabiting individuals. Most appear to be even-aged dating back to the last extensive fire ca. 1860. The denser stands are clearly senescent with trees exhibiting effects of overcrowding.

Currently the Mayfield cRNA is being evaluated ecologically (David Imper, pers. comm 1990) and further comparisons may be made when this survey is completed.

Eastside Ponderosa Pine:
This is the only economically important timber type occurring within the TCRNA. It occupies the more weathered basalt of the northern and western sides of the area and clearly shows a pattern of increasing density with increasing soil depth. Typically, it is an open forest (photo 2) with widely spaced ponderosa pines in the canopy and scattered subcanopy trees of western juniper (*Juniperus occidentalis* ssp. *occidentalis*) and Oregon oak (*Quercus garryana*). Chaparral shrubs such as green leaf manzanita (*Arctostaphylos patula*) and buckbrush (*Ceanothus cuneatus*) are the dominant understory species, but mix with more interior Great Basin species such as bitterbrush (*Purshia tridentata),* Great Basin sagebrush *(Artemisia tridentata*), and curl-leaf mountain mahogany (*Cercocarpus ledifolius)*.

The eastside ponderosa pine target element is already represented for the Modoc Plateau by the Blacks Mountain RNA (Roy 1975) which lies about 32 miles (52 km) southeast of the TCRNA. Blacks Mountain is at a higher elevation and has a less cismontane flavor, to the vegetation with species such as Oregon oak and buckbrush rare or absent and species such Great Basin sagebrush common. Thus, the TCRNA provides a transitional type of interior ponderosa pine forest which indicates its affinity to westside ponderosa pine and other related coniferous forests of the western slopes of the Cascades.

With dating of the lava flows in the area, a soil-vegetation chronosequence may be elucidated for the ponderosa pine forest. This may be possible because it occurs in different stages of structural and successional development on lava flows of three different ages, spanning several

thousand years.

Rocky Pools:
Despite the lack of live streams in the area, the aquatic resources are not limited to vernal pools. Another type of pool occurs in the more recent basalt flow areas. This pool is typically small (only 5-6 ft, 1.5-2 m, across) and relatively deep (up to 3 ft, 1 m). It occupies the bottom of collapsed lava tubes and usually has a rocky bottom with little aquatic vegetation. These pools may retain water well into the summer in wet years (at least to August 2, 1983, as seen on aerial photos), much longer than the deepest parts of the two vernal pools. The largest of these pools occurs about 0.25 miles (0.40 km) south of the vernal pool along the western edge of sec. 14 (SW 1/4) and is somewhat transitional with true vernal pools. It has shallower parts which contain some vernal pool species such as *Eryngium* spp., but deeper areas also contain species indicative of more permanent water such as *Isoetes howellii,* and *Heleocharis palustris*. The smaller pools, despite the absence of a well developed vascular flora, often have conspicuous invertebrate fauna such as fairy shrimp, *Daphnea*, and water beetles. The semi-permanence of these pools make them important watering holes for larger terrestrial vertebrates such as bear and deer. Several are regular bear wallows and the largest had several species of waterfowl resting on them in the spring.

Modoc Plateau Endemic Flora:
In addition to the vernal pool community mentioned above, there is a unique floristic component to the xeric basalt flows of the Modoc Plateau physiographic province. Several species common on the lava flows at TCRNA are largely or completely restricted to the lava fields of this part of California and adjacent states. They include *Agastache parvifolia, Mimulus breviflorus, Allium lemmonii, Lupinus caudatus,* and *Penstemon deustus* ssp. *heterander*. It is likely that the Baker cypress is also one of these species, particularly if genetic studies confirm expected differences between the Modoc Plateau populations and Plumas County populations.

PHYSICAL AND CLIMATIC CONDITIONS

The TCRNA lies in a rain shadow just east of the southern Cascades and Klamath Ranges. Although it is drained by the Pit River, which flows west to join with the Sacramento, the overall environment shares characteristics

with the northern Great Basin. This area lies on the western and lowest elevation edge of the Modoc Plateau. This situation strongly affects the biota of the area, which is a mixture of "eastside" and "westside" taxa and habitats.

The TCRNA occupies a series of Pleistocene and Recent basalt flows that have covered the northern floor of the Fall River Valley. This valley is a fault block structure separating the Big Valley Mountains to the east from Soldier Mountain and other Cascade Range mountains to the west. Over a distance of several miles the valley dips very gradually to the south to the Pit River in the middle of Fall River Valley. The bottom of the valley was apparently a lake bed in the Pleistocene (MacDonald 1966) and this bed was partially overridden by more recent lava flows of which those at TCRNA are a part.

The basalt at TCRNA is not primarily a product of Timbered Crater itself, which lies 1.5 miles (2.4 km) SW of the SW corner of the RNA (see maps 1 and 3). It has instead apparently come from both the Medicine Lake Highlands as a huge flow stretching south over 25 miles (40.3 km), and from Brushy Butte, a low rounded vent 1.5 miles (2.4 km) SE of the RNA in the NW 1/4 of sec. 31 T39N, R5E. Brushy Butte most recently erupted ca 4000 years ago (McDonald and Rowe 1983). There appear to be at least three different age groups of flows in the RNA. The oldest and most heavily weathered is the furthest north and underlies the beds of the two vernal pools and the adjacent well developed ponderosa pine forest on the northern border of the area. The middle-aged flow(s) from Medicine Lake is (are) the most extensive, underlying the majority of the cypress stands and all but the southeastern part of the study area. The most recent flow(s) is (are) represented in the RNA only in the SE 1/4 of sec. 23 (for a map of the different flows see map 4).

No temperature or precipitation recording stations exist within or adjacent to the RNA. McDonald and Rowe (1983) estimate the precipitation in the area to average 25 in (635 mm) with about 30% falling as rain and 70% as snow. The isohyets in Rantz (1972) and in Stone (1965) show the area receiving an annual average of between 16 to slightly over 20 inches (406-508+ mm). Only 16 miles (26 km) west on the crest of the Cascades rainfall exceeds 80 inches (2032 mm) annually (Rantz 1972). Rainfall seasonality is similar to the Hat Creek Power House #1 ca. 16 miles (26 km) southwest of

the RNA (Goodridge 1981). The mean monthly precipitation, in inches (with mm), between 1941 and 1970 was as follows:

Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Tot.
3.16	2.55	1.98	1.36	1.25	1.01	0.23	0.27	0.40	1.30	2.19	3.28	18.98
(80)	(65)	(50)	(34)	(32)	(26)	(6)	(7)	(10)	(33)	(56)	(83)	(482)

Unlike many other areas of cismontane northern California this region receives about 0.25 in (6.5 mm) or more precipitation per month even in the summer. This is primarily a result of orographic thunderstorms associated with the relatively high elevations of the surrounding terrain. According to Donley et al. (1979) the average annual water surplus is zero but the average annual water deficit is only 7.8-15.7 in (20-40 cm). Thus, the area is in a zone of low precipitation and a short groundwater recharge period, but also a relatively low net water deficit. Donley et al. show the area as being on the border between a Mediterranean climatic type and a microthermal climate type both with the average warmest month over 71.6° F (22°C).

Temperature patterns for the area may be summarized from Donley et al. (1979). Highest temperatures occur in late July and lowest temperatures occur in early January in most years. The mean January temperature falls within the range of 26.6-32°F (-3 to 0°C) and the mean July temperature is in the range of 64.4-69.8°F (18-21° C). The frost free period averages between 120-180 days, the average number of days with the maximum temperature above 90° F (32° C) is under 30. The average number of days with minimum temperatures below 32°F (0°C) is between 150-180 per year. According to McDonald and Rowe (1983) temperatures range from an annual high of about 105° to a low of -30° F (40.6 to -34.4° C).

During the four day visit to the area in mid-May 1989 the high temperatures ranged from 60-72°F (15.5-22.2° C) and the lows ranged from 30-37° F (-1.1-2.7° C). The skies were partly cloudy on three of the four days with light afternoon showers (associated with a weak weather front) on two days.

VEGETATION AND FLORA

The flora of the TCRNA is relatively rich for a Modoc-Cascade site, containing at least 161 taxa of vascular plants. The Devil's Garden RNA on

Table 2: Acreage of vegetation types in Timbered Crater candidate RNA.

Vegetation Type: (with Holland, Kuchler, and SAF code equivalents)	acres	hectares	% of total
Baker cypress forest (H83220, no K or SAF)	560	227	31.5
Northern Basalt Flow Vernal Pool (H44131, no K or SAF)	27	11	1.5
Knobcone Pine Forest (H 83210, SAF 248, no K)	136	55	7.7
Eastside Ponderosa Pine Forest (H84220, SAF 237, K 15)	1044	422	58.8
(dense phase)	(52)	(21)	(2.9)
(open phase)	(992)	(402)	(55.8)
rocky pool (no H, SAF, or K)	10	4	0.6
totals:	1777	719	100.1

the Modoc National Forest (Keeler-Wolf 1983) is only known to contain 102 taxa, while the topographically more diverse Shasta Mudflow (Keeler-Wolf 1984), and Shasta Red Fir (Imper 1988) RNAs are known to contain only 95 and 87 taxa respectively. The generally low species diversity of this region is attributed to the recent vulcanism and relatively harsh climate of the area (Imper 1988). The higher diversity of the TCRNA flora is most directly related to the well developed vernal pool habitat, the relatively low elevation and equitable climate and the variation in age of the substrates.

Associated with the vernal pools are four taxa of plants considered rare by CNPS (Smith and Berg 1988). *Orcuttia tenuis* (CNPS list 1b, a plant of highest priority) has had a species management guide written for the Lassen N.F. and adjacent BLM populations (Corbin and Schoolcraft 1989). The populations at the two vernal pools at TCRNA represent half of all the sites known for this region. The other species are less well documented. *Eryngium mathiasiae* (CNPS list 4, a plant of limited distribution) is a relatively widespread, but recently described species endemic to the Modoc Plateau region (Sheikh 1983). *Cuscuta howelliana* (CNPS list 4) is a species known from several Coast Range and Sacramento Valley vernal pool populations but is at its highest elevation and most northeastern known station in the RNA , and *Thermopsis macrophylla* var. *argentata* (CNPS list 4) is an endemic to Modoc and Shasta Counties (photo 3).

VEGETATION TYPES:
The vegetation map (map 5) is organized using the system of Holland (1986). Following is a description of the major plant associations occurring in the TCRNA. The code numbers following the names of the associations are Holland type numbers. Associations are listed in order of decreasing size. See Table 2 for acreage of Holland and equivalent Kuchler (1966), and SAF (Eyre 1980) vegetation types.

Eastside Ponderosa Pine Forest (84220):
This forest, dominated by ponderosa pine occurs in two forms in the RNA. The most extensive form occupies the older of the two Recent lava flows in the northern and western parts of the RNA. It is characterized by an open canopy (ca 35-100 trees/ha) of ponderosa pine ranging in height from 60-100 ft (20-30 m) and in diameter from 18-37 in (46-94 cm). Beneath this canopy is a variable poorly developed subcanopy made up of western juniper and Oregon oak (photo 10). Both of these species are patchy in their

distribution, the juniper most common on relatively level, unrocky surfaces (relatively heavily weathered), while the oak occurs most commonly on rough undulating lava. Most junipers are under 18 in (46 cm) dbh and 40 ft (12.2 m) in height. Most Oregon oaks are spindly and multi-stemmed, verging on the shrubby variety *breweri*. However, some may be up to 25 ft (8 m) tall and 12 in (30 cm) dbh. The shrub cover of this open woodland/forest is relatively uniform with *Arctostaphylos patula* and *Ceanothus cordulatus* dominant and other species such as *Cercocarpus ledifolius, Holodiscus boursieri, Cercis occidentalis, Ceanothus integerrimus,* and *Prunus emarginata* scattered throughout.

The distributions of the three members of the cypress family, western juniper, incense-cedar (*Calocedrus decurrens*) and Baker cypress, are negatively correlated. Baker cypress rarely occurs on the flat well weathered flow areas where western juniper tends to co-dominate with ponderosa pine. Incense-cedar typically occurs on the well developed soils of older lava flows where juniper and cypress do not grow.

An anomalous stand of open ponderosa pine forest with some large Oregon oak and curl-leaf mountain mahogany occurs on a lobe of the Recent Brushy Butte flow in the NE 1/4 Sec 26 on BLM land. This is a rough, jumbled flow and yet it has some relatively large and dense trees up to 37 in (94 cm) dbh including a few mature incense-cedar. These large trees have no fire scars. Apparently this flow, with its many hollows and small rocky crags (photo 11) has had insufficient brush cover to sustain a major fire, while the hollows have accumulated enough soil and moisture to enable the trees to attain large size. This particularly rugged and high relief flow area is also unusual in that it doesn't have any Baker cypress. Baker cypress is abundant on surrounding flows of the same age, but the extremely rocky and open nature of this flow and the lack of fire in the area may have prevented colonization of cypress.

The understory of the open ponderosa pine forest is well stocked with a variety of herbs. In a normal to wet year these are conspicuous and may cover 10-25% of the ground in openings between the shrubs (photo 12). Common species include: *Lomatium nudicaule, L. nevadense, Blepharipappus scaber, Horkelia tridentata, Zigadenus paniculatus, Bromus tectorum, Festuca idahoensis, Poa fendleriana, Collinsia parviflora, Linanthus bakeri,* among others. *Lomatium dissectum* and *Chamaebatiaria millefolium* are a conspicuous presence in the rougher lava areas.

Dense Phase Eastside Ponderosa Pine: A very small part of the TCRNA adjacent to the vernal pools has a much denser and more well developed ponderosa pine forest (photo 13). This type occurs on much older soils of the Adobe Flat area. This forest is dominated by ponderosa pine, but also has incense-cedar and occasional sugar pine (*Pinus lambertiana*) and California black oak (*Quercus kelloggii*). It has a higher stand density of over 150 trees/ha and an open understory of *Ceanothus integerrimus, C. prostratus,* and greenleaf manzanita. Herb cover is substantially different from the open stands with such species as *Astragalus pulsiferae* var. *suskdorfii, Wyethia angustifolia, W. mollis, Lupinus andersonii,* and *Calystegia* sp. This type of forest also occurs on BLM land in a small kipuka (old, well vegetated lava flow surrounded by younger flows) in the NW 1/4 Sec 24.

Northern Interior Cypress Forest (83220):
Baker cypress tends to occur in relatively dense stands and only rarely occurs as isolated individuals. Stands may consist of a few score of individuals to many thousands. In general, the northern and western perimeter of the population (including the majority of the trees in secs 12, 14 and 23) tends to be more fragmented than the eastern and central portion of the Timbered Crater population. Thus, most of the Forest Service RNA stands are semi- discrete. Frequently the highest density stands are associated with raised lava ridges which are 10-30 ft (3-10 m) above the surrounding terrain (photo 14). Additional stands occasionally occur on relatively flat unbroken ground. These stands are interspersed with patches of open eastside ponderosa pine forest or brushfields dominated by *Arctostaphylos patula*.

Densities of individual cypress stands are typically high (over 1000/ha), but variable. The density of a given stand depends upon the substrate (typically lower on flat, relatively poorly drained ground), and also depends upon the prior density of cone-bearing trees which released seed following the last fire.

Cone production of Baker cypress can begin in less than 10 years after germination (photo 15). The conditions necessary for good cone production vary greatly from year to year. By observing the number of cone clusters on a given individual and determining its age, an estimate of the number of

good reproductive years can be made. In general, most Baker cypress in the RNA are not producing cones at a frequency greater than one crop every 7-10 years. Based on the estimated period of growth to the most recent cone cluster on many trees, the last good cone years were the wet years of 1982-83.

Vegetation Sampling: Ten 100 m^2 plots were sampled in the Baker cypress forest in the eastern half of sec 14. and the adjacent portion of sec 23. Plots were selected at 50 m intervals along a transect. In each plot all trees over 2 m tall were counted and their dbh measured. All species of shrubs and herbs were noted on the plots with their percent cover estimated. Table 2 and 3 present these data.

Baker cypress is virtually the only tree in most of the stands with only rare individuals of ponderosa pine, western juniper, and Oregon oak. Knobcone pine is a co-dominant in a portion of the area, in secs. 23 and 24 (not on sample plots). This vegetation is considered more completely in the next section.

The understory is dominated by greenleaf manzanita. This widespread shrub, characteristic of montane chaparral throughout northern and central California, occurred on 100% of the plots and averaged 33% cover. Its tolerance of dry, rocky soil and its resprouting ability makes it a logical understory dominant for the fire-adapted Baker Cypress, knobcone, and open ponderosa pine forests. Additional shrubs of lesser importance include bitterbrush (a nitrogen-fixer), buckbrush, *Ceanothus integerrimus, Cercocarpus ledifolius, Holodiscus boursieri,* and *Cercis occidentalis* (the last three species are particularly associated with rough lava slopes and outcrops). These shrubs are a mixture of montane, foothill, and transmontane vegetation elements and underscore the transitional nature of the flora.

Understory herbs are surprisingly diverse, with 32 species noted in the 1000 m^2 sample (see Table 3). Although they rarely account for more than a trace amount of cover, several small annual species are abundant and widespread. These include *Madia minima, Epilobium minutum, Vulpia reflexa, Plagiobothrys tenella, Arenaria douglasii,* and *Collinsia parviflora*. Perennial species such as *Carex rossii, Penstemon deustus* ssp. *heterander, Horkelia tridentata,* and *Eriogonum* spp. are widespread,

Table 2: Sampling data for trees from ten 100 m^2 plots in Baker Cypress forest at Timbered Crater RNA, Siskiyou County.

	Density (ha^{-1})	Frequency (%)	Basal Area (m^2/ha)	Rel. Den.	Rel. Freq.	Rel Cov.	Imp.Val.[2]
B.cyp.	2530	100	12.65	0.981	0.833	0.944	275.8
W.jun.	20	10	0.74	0.008	0.083	0.055	14.6
Pond.p.	30	10	0.01	0.012	0.083	0.001	9.6

Table 3: Percent cover and frequency for shrubs and herbs on ten 100 m^2 plots in Baker cypress forest at Timbered Crater RNA, Siskiyou County.

species	frequency	cover
shrubs:		
Arctostaphylos patula	100	33.2
Purshia tridentata	60	1.0
Cercocarpus ledifolius	50	0.5
Ceanothus cuneatus	40	0.5
Ceanothus integerrimus	20	0.1
Cercis occidentalis	10	tr.
Ceanothus prostatus	10	tr.
Holodiscus boursieri	10	tr.
herbs & graminoids:		
Madia minima	100	0.3
Vulpia reflexa	80	tr.
Carex rossii	70	tr.
Epilobium minutum	60	0.2
Penstemon deustus heterander	50	tr.
Plagiobothrys tenellus	50	tr.
Viola purpurea dimorpha	50	tr.
Arenaria douglasii	30	tr.

[2]Importance value= relative density + relative frequency + relative cover x 100.

Table 3 continued:

species	frequency	cover
Arabis holboellii retrofracta	30	tr.
Collinsia parviflora	30	tr.
Blepharipappus scaber	20	tr.
Draba verna	20	tr.
Festuca idahoensis	20	tr.
Horkelia tridentata	20	tr.
Erigeron inornatus	20	tr.
Eriogonum marifolium	20	tr.
Lomatium nevadense	20	tr.
Mimulus nanus	20	tr.
Poa fendleriana	20	tr.
Agoseris heterophylla	10	tr.
Bromus tectorum	10	tr.
Calyptridium umbellatum	10	tr.
Claytonia spathulata exigua	10	tr.
Delphinium nudicaule	10	tr.
Eriogonum umbellatum polyanthum	10	tr.
Eriophyllum lanatum	10	tr.
Linanthus bakeri	10	tr.
Phacelia mutabilis	10	tr.
Polygala cornuta	10	tr.
Microsteris gracilis	10	tr.
Microsteris natans	10	tr.
Senecio eurycephalus	10	tr.

but scattered.

Growth Rates: Although the vast majority of Baker cypress at TCRNA date back to ca 1860, there is substantial variation in growth rates. This variation depends upon site characteristics such as soil depth and crowding. The fastest growing trees occur in pockets of soil and moisture accumulation at the bases of lava outcrops and particularly in the bottom of sinkholes (photo 16). The tallest Baker cypress noted was 72 ft (22 m) tall with a dbh of 19 inches (48 cm). It was aged at 2 ft (61 cm) from the base as 119 years. The slowest growing individuals are those in extremely crowded stands on the rocky slopes of lava ridges. These may only be 0.5 to 1.0 in (1.2-2.5 cm) dbh and 6-9.5 ft (2-3 m) tall, but again average over 100 years old. The largest of the trees in the ca. 1860 generation occur in open stands on flats (photo 17). The oldest trees occur as isolated individuals on flats. The largest noted in the area was 24.5 in (62.2 cm) dbh and ca 60 ft (18.3 m) tall. This individual was ca 224 years old.

The Horrs Four Corners Fire and General Fire History: On August 3, 1977 during a period of major drought, a lightning strike started a fire to the south of the RNA. By the time this fire was controlled on August 18, 9580 acres (3877 ha) had been burned (Note: this is a separate fire from the huge Pondosa fire, starting at the same time and burning twice the area a few miles to the west of the RNA). This fire entered the southern portion of the Timbered Crater Baker cypress population including the south 1/2 of secs 25 and 26 (see map 5). Where this fire overlapped stands of Baker cypress there is now considerable reproduction. In May 1989, the number of cypress saplings was impressive in many areas between road 39N99 and the knobcone pine forest ca 0.25-0.5 miles (0.4-.8 km) to the north (photo 18). In many areas the skeletons of the burned cypress are still standing and indicate areas of dense stands interspersed with areas of little or no cypress, similar to peripheral stands of cypress along much of the northern and western part of the Timbered Crater population (note: Figure 1 in Stone 1965, was taken in this area). Highest densities of saplings are typically associated with bulldozed fire lines and roads or areas of previously dense stands.

Heights of the cypress saplings, and thus rates of growth appear variable. The tallest individuals are ca 7 ft (2.1 m) while the shortest are about 2 in (5 cm). Some of these small individuals may have germinated more than one year after the fire. The average height of saplings in 1989 was about 3 ft

(1 m). Vegetation is often dense in the burned area, often dominated by cypress saplings, but also consisting of vigorous *Ceanothus integerrimus, Prunus emarginata, P. virginianus* ssp. *melanocarpa, Arctostaphylos patula,* and Oregon oak.

Aside from the big fire of 1977 there have been no extensive fires in the area since the major conflagration ca 1860. The fire atlas at the Hat Creek Ranger Station shows no fires in the area, save a few spot fires between 1935 and 1977.

Successional Relationships and Competition: The Baker cypress at Timbered Crater occupies the young, relatively unweathered lava flows. As was mentioned previously, it is not known from the most rugged Recent lava outcrops where fire may not be able to spread. It is also not known from the older highly weathered Pleistocene flows in the Adobe Flat area and on the kipuka in the NE 1/4 of sec 24. These areas are occupied by relatively dense eastside ponderosa pine forest. The dense and tall ponderosa pine is probably competitively superior to Baker cypress on these deep-soil sites, and may shade out Baker cypress relatively quickly just as white and red fir do to Baker cypress at the Mud Lake RNA.

Perhaps more importantly, the fire frequency of these ponderosa pine forests may have averaged greater than 1 every 10 years prior to the past century of fire suppression, thus preventing the establishment of reproductive cypresses. This point may seem a paradox, as the cypress requires fire for germination. However, several species of cypress have been shown to suffer population declines as a result of high fire frequencies (e.g. Scheid and Zedler 1989) and ponderosa pine forest elsewhere on the Lassen National Forest has been found to have sustained ground fires in pre-suppression days on the order of from 8-15 years (Roger Evans, Almanor Ranger District, pers. comm. 1990). A ground fire may not be lethal to the rapidly growing and fire-resistant ponderosa pine, but will almost be certain to kill the short-statured non-resistant cypress.

Compared to knobcone pine, Baker cypress is more tolerant of crowding and the effects of competition. In the area where the two species co-occur knobcone is less shade tolerant and substantially less tolerant of extreme crowding than Baker cypress. Baker cypress is remarkable for its tolerance of crowded conditions. Some areas were sampled with densities of 8400/ha

and yet very few dead stems were counted (less than 1%). This is despite the fact that many of the stems were clearly over 100 years old and only averaged slightly over 1.5 inches (3.8 cm) dbh. In contrast, the highest density knobcone pine stands at TCRNA were ca. 1300/ha and in such stands, many were dead (ca. 20%).

As the Recent lava flows weather over the next few thousand years, conditions will become less favorable for the continued dominance of Baker cypress (provided fire returns to pre-suppression frequencies). In the future, given a similar climate, as the soil becomes better developed, ponderosa pine forest will gradually replace the Baker cypress forest at Timbered Crater. Under such conditions, it is likely that only a relatively low frequency of fires (all of which crown out) could maintain Baker cypress dominance.

Knobcone Pine Forest (83210):
Knobcone pine is the most widespread of the California closed-cone pines (Griffin and Critchfield 1976). However, this association is the most restricted of the forest types in the RNA. It occurs in a well-circumscribed area of ca. 593 acres (240 ha) on Forest Service and BLM lands with no other stands within several miles (see map 5). The local stand of knobcone pines is near the northeastern limit of its distribution with only one other stand known from Modoc County (about 12 miles, 19 km NE). Perhaps one of the reasons the Timbered Crater stand is relatively restricted is that it is near the edge of its zone of environmental tolerance with periodic drought and cold weather limiting its local success.

The TCRNA knobcone pine forest environment is generally similar to the majority of the Baker cypress forest. However, the northern part of the stand is bounded by relatively flat mixture of open ponderosa pine and Baker cypress. The southern limit of the stand is bounded by the most recent and roughest of the lava flows, and the eastern part of the stand is bounded by the small kipuka with dense ponderosa pine forest. Thus the knobcone pine stand is limited to a relatively rugged ridge and hollow system of lava which appears less weathered than the flows to the west, north and east, but older than the flows to the south.

It seems likely that the knobcone may be limited to this area by a combination of environmental characteristics. First; the hollows between

the lava ridges accumulate more soil and water than the surrounding terrain. This is an important consideration for a species near the edge of its zone of tolerance for moisture (it rarely occurs in areas with less than 20 in, 508 mm, of average annual rainfall). Secondly; the fire history of surrounding areas may have played an important role in its restriction. At Timbered Crater, Baker cypress is better able to survive long fire intervals, while ponderosa pine may be able to survive a higher frequency of fires than knobcone.

Vegetation Sampling: The TCRNA knobcone forest is characterized by a dense, even-aged canopy of spindly pines averaging 40-60 ft (12-18 m) in height and 9-13 inches (23-33 cm) dbh. Beneath the canopy is a relatively continuous subcanopy dominated by Baker cypress and suppressed knobcones. The sampling plots (ten 100 m^2 plots laid out along a transect using same methods as for Baker cypress sampling) indicate comparable importance values for Baker cypress and knobcone (Table 4). Baker cypress density averages over twice as high as knobcone. However, knobcone pine basal area cover is substantially higher than the cypress. The presence of occasional large ponderosa pine and the regular presence of clonal clumps of Oregon oak suggests that the soil development and its moisture holding capacity is greater than the typical pure stands of Baker cypress (see previous section and table 3). As with the Baker cypress plots, saplings and seedlings of the two dominant fire-dependent species are absent.

The understory species (Table 5) are similar to those in Baker cypress stands. However, cover of the dominant greenleaf manzanita averages lower than in most pure Baker cypress stands. This may be the result of the higher shading of the understory. The knobcone canopy and Baker cypress subcanopy of the forest does create relatively shady conditions for heliophiles such as greenleaf manzanita. Overall density and cover of all understory species is low in the densest stands. The greater frequency of such relatively shade-tolerant mesophytic species as *Poa fendleriana, Claytonia spathulata, Cystopteris fragilis,* and *Collinsia parvifolia* on the knobcone plots compared to the cypress plots also underscore the different understory conditions.

Ages and Growth Rates: Virtually all knobcone pine at TCRNA originated from the same fire which rejuvenated the majority of the Baker cypress stands ca 120 years ago. Trees as large as 24 in (61 cm) dbh and as small as 5 in (12.7 cm) dbh had approximately equal ages. The largest knobcone

Table 4: Sampling data for trees from ten 100 m^2 plots in knobcone pine forest at Timbered Crater RNA, Siskiyou County.

	Density (#·ha^{-1})	Frequency (%)	Basal Area (m^2/ha)	Rel. Den.	Rel. Freq.	Rel Cov.	Imp.Val.
K.Pine	610	90	16.63	0.265	0.375	0.533	117.3
B.Cyp.	1580	100	5.09	0.687	0.417	0.163	126.7
O.oak	90	30	0.33	0.039	0.125	0.011	17.5
P.pine	20	20	9.17	0.009	0.083	0.294	38.6

Table 5: Percent cover and frequency for shrubs and herbs on ten 100 m^2 plots in Baker cypress forest at Timbered Crater RNA, Siskiyou County.

species	% frequency	cover
shrubs:		
Arctostaphylos patula	90	9.7
Purshia tridentata	40	0.6
Cercis occidentalis	20	tr.
Ceanothus cuneatus	10	tr.
Ceanothus integerrimus	10	tr.
Chrysothamnus nausiosus	10	tr.
herbs and graminoids:		
Poa fendleriana	90	tr.
Collinsia parviflora	60	tr.
Vulpia reflexa	60	tr.
Festuca idahoensis	50	tr.
Claytonia spathulata exigua	40	tr.
Viola purpurea dimorpha	30	tr.
Madia minima	30	tr.
Plagiobothrys tenellus	30	tr.

Table 5: (continued)

species	% frequency	cover
Comandra pallida	30	tr.
Eriogonum umbellatum polyanthum	30	tr.
Arabis holboellii retrofracta	20	tr.
Arenaria douglasii	20	tr.
Carex rossii	20	tr.
Linanthus bakeri	20	tr.
Lithophragma parviflorum	20	tr.
Lomatium nevadense	20	tr.
Zigadenus paniculatus	20	tr.
Agoseris heterophylla	10	tr.
Bromus tectorum	10	tr.
Clarkia sp.	10	tr.
Cystopteris fragilis	10	tr.
Delphinium nudicaule	10	tr.
Draba verna	10	tr.
Erigeron pumilis intermedius	10	tr.
Eriogonum nudum	10	tr.
Leptodactylon pungens	10	tr.
Mimulus breviflorus	10	tr.
Microseris sp.	10	tr.
Penstemon deustus heterander	10	tr.
Phacelia mutabilis	10	tr.
Poaceae sp.	10	tr.
Senecio eurycephalus	10	tr.
Thysanocarpus curvipes	10	tr.

pines (up to 85 ft tall, 26 m) are associated with deeper soils in hollows, while the smallest trees occur in dense thickets on thin, rocky soils.

Northern Basalt Flow Vernal Pool (44131):
The vernal pools at TCRNA are collectively known as the Adobe Vernal Pools (Corbin and Schoolcraft 1989). The two pools in the RNA are similar in size and general characteristics and are partially interconnected through a chain of small, narrow moist (in May) meadows running along the border of the Recent and Pleistocene flows (SW 1/4 sec 11, NW 1/4 sec 14). It appears likely that prior to the Recent lava flow the vernal pool habitat was more extensive in the area. Gassaway Reservoir (W 1/2 Sec 7 T39N, R5E) is another pool area along the edge of this same lava flow about 2 miles (3.2 km) east of the northern vernal pool. The extensive flats (many of which were vernal pools before being developed agriculturally) in Little Hot Spring Valley, Green Place Reservoir, and the central Fall River Valley may have all been virtually interconnected prior to the major flows from the Medicine Lake Highlands and Brushy Butte.

The two pools in the TCRNA are both underlain by claypan soil derived from basaltic lava (Supan series according to G. Kliewer, Soil Scientist on the Lassen N.F.). However, the clay at the southern pool appears to be somewhat finer grained and less permeable than that of the northern pool. Perhaps these subtle soil differences account for some of the difference in the vegetation of the two pools.

Both pools have extensive flats associated with them. These are waterlogged for a much shorter period than the adjacent lower portion of the pools. At the southern pool these flats appear alkaline with some evidence of a whitish salt deposit on the soil surface. Associated with this pool are species such as *Hesperochiron pumilis* and *Balsamorhiza hookeri,* (photo 4) known to be tolerant of alkaline soils (Munz 1968). These species appear absent from the northern pool flats. Additional species common or abundant only at this southern pool flat area include *Allium lemmonii* (photo 5), *Orthocarpus campestris* , *Lomatium piperi* , *Triteleia* sp. and *Perideridia* sp. The main body of both pools, still moist to wet in May 1989, contained the following dominants: *Eryngium mathiasiae, Plagiobothrys bracteatus, Cuscuta howelliana, Navarretia minima,* and *Psilocarphus brevissimus* (photo 6). Later in the season such species as *Eremocarpus setigerus, Grindelia camporum* , and *Deschampsia*

danthonoides (among others) are dominant.

Three species of *Downingia* have been collected from the two pools. All of them appear to be more strongly tied to lingering moisture than the above species, often lining edges of natural or excavated pit-reservoirs. In May 1989, *D. bicornuta* (photo 7) was the prevalent species at the northern pool, while *D. cuspidata* was the prevalent species at the southern pool. *D. bacigalupii* is a later flowering species, collected by Corbin and Schoolcraft in June (Schoolcraft pers comm May 1990).

Orcuttia tenuis has a rather unpredictable distribution. Recently germinated plants were seen in mid-May 1989 only along the pit reservoir edge at the northern vernal pool. Corbin and Schoolcraft (Corbin pers. comm. 1989) found it in June 1988 and 1987 along the southern edge of the main southern pool and along the edge of the main northern vernal pool, but not at the northern pit reservoir. I did not notice any plants at the locations noted by Corbin in 1988. Clearly annuals such as *Orcuttia* as well as many of the other vernal pool species may have widely fluctuating population levels depending on the yearly climatic and environmental conditions. Other species with infrequent distributions at the pools include: *Pogogyne zizyphoroides, Machaerocarpus californicus, Myosurus minimus, Mimulus tricolor* (photo 8), *Gratiola ebracteata, Claytonia dichotoma, Lythrum hyssopifolia, Polygonum douglasii* var. *johnstonii, Eryngium alismaefolium*, *Boisduvalia glabella*, and *Polygonum* sp. (possibly including the rare *P. minimum* var. *esotericum*).

The deepest parts of both pools are dominated by *Heleocharis palustris, Polygonum amphibium* var. *stipulaceum* and emergent leaves of *Eryngium mathiasiae* in mid-May 1989. These pools at this time were ca 12-15 in (30-38 cm) deep. It is clear that even in wet years such as 1983 these pools are completely dry by early July (July 3, 1983 aerial photos). The deeper portions of both pools have a scattering of flattened basaltic boulders from 1-3 ft (30-91 cm) in diameter (photo 9). Water lines on these boulders indicate maximum depths of ca 2 ft (61 cm) for both pools. Water availability may average somewhat greater at the southern pool than the northern, as indicated by an intermittent fringe of Oregon ash (*Fraxinus latifolia*) along the western and southern sides of the southern pool. There are no strictly riparian woody plants associated with the northern pool.

Rocky-Bottomed Pools (no Holland classification):
The presence of several small rock-bound pools ranging from 2 ft (61 cm) to 250 ft (76.2 m) across has already been noted (photos 19 and 20). Aquatic vegetation is only developed in the largest pools . The characteristics of the rocky pool differs from the vernal pool association because of the lack of claypan and the presence of a relatively unbroken rocky bottom. It also differs because many of these rocky pools retain water longer than the vernal pools. The largest pool in the SW 1/4 sec 14 has a riparian fringe of Oregon ash with occasional willow (*Salix* sp.). Despite the physical differences, species composition of the large rocky pool is similar to the deeper parts of the vernal pools. The shallow portions of the pool are dominated by *Heleocharis palustris, Heleocharis* sp., *Eryngium* spp. (not in flower at time of survey), *Polygonum amphibium,* and *Callitriche* sp. Deeper portions are up to 2 ft. (61 cm) deep and have a much sparser cover of the same plants.

The persistence of water in several of these pools suggests that the bottoms of some of these pools are close to the water table which presumably underlies the Recent lava flows.

FAUNA

The relatively low productivity of most of the vegetation types in the TCRNA has a direct effect on the density and diversity of the fauna. Only in the aquatic habitats, the vernal pools and rocky pools, are faunal density and diversity notably high.

No inventory was made of the invertebrate fauna of the pools. However, even relatively small rocky pools had such crustaceans as fairy shrimp, *Daphnea* sp., *Cyclops* sp. as well as aquatic insects such as mosquitos (Culicidae), predaceous diving beetles (Dytiscidae), and whirligig beetles (Gyrinidae). The vernal pools and large rocky pool had additional invertebrate species such as back swimmers, water boatmen, caddisfly larvae, dragonfly and damselfly larvae as well as vertebrates such as garter snakes (*Thamnophus elegans*), long toed salamander larvae (photo 21), boreal toads (*Bufo boreas*), Pacific tree frogs (*Hyla regilla*), mallards, wood ducks, and Canada geese.

The most abundant vertebrates of the terrestrial habitats included rufous-

sided towhees, Pygmy nuthatches, Ash-throated Flycatchers, Steller's jays, Beechey ground squirrels, Audubon's cottontails, and dusky footed woodrats.

A complete list of all vertebrates noted (40 species) during the field work for this report is presented in Appendix 2.

GEOLOGY

The entire area is underlain by Quaternary volcanic rocks of either Pleistocene or Recent (Holocene) origin. More specifically these rocks are basaltic flows which have either emanated from the Medicine Lake Highlands to the north or from Brushy Butte to the south.

The Fall River Valley is a fault block valley with the steepest scarp and lowest elevations along the east side of the valley (abutting the Big Valley Mountains). An enormous lava flow of dark basalt fills the whole northern end of the Fall River Valley. It was erupted sometime within the last few thousand years from one of the volcanoes in the Medicine Lake Highlands and flowed for almost 40 miles (64 km) to the present edge of Big Lake, Crystal Springs, and Horr Pond ca 7 miles (11.2 km) north of Fall River Mills (Alt and Hyndman 1975). At the edge of this flow is Fall River Springs, one of the largest spring complexes in the country (flow ca 1.29 billion gallons/day). The water appears to be coming from the Tule Lake and Clear Lake Reservoir area ca 50 miles (81 km) north. These springs issue from the bottom edge of the lava flow (ca 3.5 miles , 5.6 km south of the RNA) where it contacts the Pleistocene lake bed sediments that fill the lower part of Fall River Valley (MacDonald 1966).

The lavas of the RNA and adjacent BLM land appear to be principally derived from the Recent Medicine Lake flow. However, as was described earlier, older Pleistocene and younger Holocene flows exist in the area (see map 4).

Older Pleistocene Flows: These underlie the vernal pools and adjacent dense ponderosa pine forest of the northwestern margin of the RNA. They also outcrop on the small kipuka mentioned in the NE 1/4 sec 24. These old flows appear to be fragmented remains of a contiguous series of flows from Timbered Crater. Timbered Crater was active in the Pleistocene (Jennings et al. 1977) and the soil and vegetation around its base is very similar to that of the previously mentioned areas. These older flows are characterized by dull reddish-orange weathered surface rock and soil. Soil

is relatively deep in some places and rocks are usually widely scattered on the flatter surfaces. There is little evidence of crevices, fissures, and raised lava ridges. Exposed rocks indicate the lava was relatively vesicular. The well developed claypan soils of the vernal pools attests to the well weathered physiognomy and relatively great age of this flow.

The Medicine Lake Highland Flows: This sequence is several thousand years old (perhaps about twice as old as the most recent flows, or ca. 8000 years). This flow surrounded Timbered Crater and buried much of its lava. The basic physiognomy of this sequence is of a series of winding lava ridges interspersed with relatively flat featureless areas. The lava "snakes" tend to have a characteristic physiognomy. They are typically 10-30 ft (3-9 m) high with a fissure running along the central spine. This fissure may be up to 30 ft deep and represents the partially collapsed lava tube created as the last of the molten lava flowed out of the congealed shell of the ridge. Associated with these "snakes" are occasional symmetrical depressions ("sinkholes") where a more complete collapse took place. It is these areas which are frequently the site of a temporary rocky pool or contain unusually large Baker cypress or knobcone pine.

The lava of this area is still relatively unweathered and dark. It is often highly vesicular and in some areas shows ropy pahoehoe texture.

Brushy Butte Flows: The 4000± year old flow is most widespread on BLM lands to the south and east of the RNA. In actuality the "flow" is probably a series of several closely spaced flows which descended the slopes of Brushy Butte in several different directions. The flow that enters the RNA in the SE 1/4 sec 23 is composed of very rough, angular lava. In many places vegetation covers less than 10% of the flow (photo 22) and relief is relatively high (over 30 ft, 10 m). This flow does not show the characteristic snakelike ridges and associated collapsed fissures of the Medicine Lake series and appeared to have been a more viscous type of magma.

SOILS

The soils of the TCRNA may be divided into five mapping units (see map 6). The brief descriptions of these units are from the latest revision of the Soil Rescurce Inventory of the Lassen National Forest (Kliewer 1983).

The most extensive mapping unit in the area is the Lava Flow-Lithic Xerochrepts complex, 0-35% slopes. This unit consists of shallow well drained soils on recent basalt flows. Soil depth is about 18 in (46 cm) to hard slightly fractured basalt bedrock. The A horizon is a slightly acid to neutral loamy sand or sandy loam with 5-15% pebbles and cobbles. The B horizon is a slightly acid to mildly alkaline sandy loam or loam with up to 75% pebbles and/or cobbles. It usually averages over 35% rock fragments.

The next most extensive unit is simply termed lava flow. It is associated with the most recent Brushy Butte Flow in the SE 1/4 sec 23, and is also mapped for part of the Medicine Lake flow in the northwestern part of sec 14. It consists of exposed very lightly weathered basalt. Slopes are variable due to the craggy nature of the flow (5-90%). The few woody plants on this map unit are associated with fractures in the flow rock and in small colluvial pockets of soil.

The third mapping unit on the TCRNA is the Supan Family 0-15% slopes. This type underlies the two vernal pools. It consists of moderately deep to very deep well drained soils formed from weathering of volcanic material. Depth to a lithic or paralithic contact (bedrock) ranges from 26 to over 60 in (66-152+ cm). The A horizon is a slightly acid to mildly alkaline sandy loam with few thin clay film colloids. However, the B horizon increases to moderately thick clay films with a sticky and plastic texture. It is a clay loam with slightly acid to moderately alkaline pH and contains at least 1.2 times the clay content of the overlying horizon.

The next type in the area is the Skalan (60%)-Holland (30%) families association 0-35% slopes. this soil underlies the well-developed ponderosa pine forest to the west of the vernal pools. It is a relatively deep (44-60 in.), mildly acidic soil derived from weathered basalt. The surface is a loam, the subsurface a gravelly clay loam.

The final soil unit is Holland (60%)-Skalan (30%) families association 0-35% slopes. It is closely related to the previous type and occurs in the RNA only in a small area just north of the northern vernal pool. It also has good ponderosa pine forest. This unit is considered somewhat more productive than the previous type (site class 1 versus 2).

CULTURAL VALUES

The reconnaissance report (McDonald and Rowe 1983) and Wolf (1948) discuss the old trail (39N02) which traverses the area. It was apparently originally a wagon road between two ranching communities, Day and Glenburn, and has been in existence for over 100 years. McDonald and Rowe show a photo of an old "porter" bottle which they estimate to have been discarded by a teamster no later than 1880.

Long before the construction of the wagon road, the area was in the tribal territory of the Achumawi. The large swamps associated with the Fall River Springs were important hunting grounds for waterfowl. However, the area of the RNA was probably only lightly used for hunting and gathering of root crops such as *Perideridia* (yampah), which occurs at the vernal pools and of such medicinal species as *Arctostaphylos* (berries) and *Lomatium dissectum*, common on the lava flows (Olmstead and Stewart 1978).

IMPACTS

Grazing:
The two vernal pools have had a history of light grazing use. Both areas have had small pit reservoirs dug to lengthen the duration of surface water. These reservoirs were dug many years ago and are small, shallow, and narrow. They are peripheral to the areas of most persistent naturally standing water. The pit reservoir at the northern pool is the largest of the two and has a well developed vernal pool flora (including *Orcuttia tenuis*) associated with it in addition to a few species restricted to deeper water such as *Ranunculus aquatalis*.

Actual grazing use has declined at the pools in the past several years. According to Beth Corbin, Lassen N.F. Botanist (pers. comm 1989) the permittee has not run cattle in the area for at least three years. In general, evidence of past cattle use in the pools is limited to occasional old droppings and footprints. Only one part of the northern vernal pool appeared to have been recently visited (spring 1989, footprints of a single animal).

The impact from cattle and associated range management activities in the pool areas may be classified as light with no conflict at present with the the sensitive plant habitat. The recent Forest Service land acquisition including the entire northern vernal pool area and its classification as a

botanical SIA should help insure its integrity. If cattle are again run in the area fencing of the pools may be necessary.

Recreation:
The major recreational use noted was limited to the jeep road 39N02. This area is apparently used occasionally by hunters in the fall. Litter associated with one unimproved campsite on BLM land in sec 13 was light. Very little litter was found on the Forest Service land adjacent to this trail. The lava flow features in the TCRNA are not spectacular enough to attract public attention, although some specimen rock collection at the Brushy Butte quarry (SE 1/4 sec 25) on BLM land may attract a few rockhounds.

Roads lead to within a few yards of both vernal pools, yet vehicular activity in the pool beds is virtually nil. One old track crosses the northwestern portion of the northern pool opening. This has not been driven in many years. More recent ruts occur at the northwestern edge of the southern pool, but the area receives such light use that little negative impact on the pool species is apparent.

Logging:
Some felling of widely scattered live (and dead?) ponderosa pine was noticed on the older dense stands adjacent to the two vernal pools, and in sec 12 near road 39N02. In all cases the cutting was light and took place many years ago (prior to 1965, see Stone 1965), not adversely affecting the quality of the target or associated ponderosa pine vegetation.

Fire Fighting:
A bulldozed fire line was cut for several miles through the edge of the dense cypress stand on the BLM land adjacent to the RNA. This line provided an effective barrier to the 1977 fire and followed the periphery of the burn northeast through secs 25 and 24. Its scar still remains (albeit with its surface frequently studded with dense cypress reproduction) and shows distinctly on the 1983 aerial photos of the area. It will eventually be well vegetated and it has obviously not adversely affected the predominant cypress vegetation. No evidence of fire fighting activity was noted on the proposed Forest Service RNA.

Fire Prescription:
Baker cypress and knobcone pine forests are fire type vegetation and in the absence of fire will become senescent. This is already true to some extent

with the knobcone pine. If the knobcone element at TCRNA is considered an important asset, a fire prescription should be developed upon establishment. Optimum fire frequency in the local knobcone forest (to enhance stand vigor and increase stand size) should occur perhaps every 50 years. Optimum fire frequency in the Baker cypress stands is more difficult to determine because of the more tolerant nature of cypress. Certainly, the fire of 1977 resulted in an excellent seedling crop stemming from stands over 100 years old at the time. It is likely that fire frequencies of 75-150 years would be within reason for the Timbered Crater cypress population.

MANAGEMENT CONCERNS AND RECOMMENDATIONS

Most important to the integrity of the TCRNA is that the Forest Service and adjacent BLM cypress natural areas be co-managed. Upon establishment of the TCRNA, a cooperative management plan detailing the fire prescription for cypress and knobcone stands should be implemented. The most extensive and diverse of the cypress and knobcone forests occur on BLM land. This includes the only recent reproduction for the cypress population.

Proposed Additions to BLM RNA:

Important to note is that much of the cypress stand on BLM land (including the recent reproduction) is not currently within the BLM RNA. According to Gary Schoolcraft, Eagle Lake District Botanist (pers. comm. 1990) the area will be re-evaluated in 1992 and one likely proposal would be to include the entire cypress stand as an Area of Critical Environmental Concern/Research Natural Area (ACEC/RNA).

I believe such a proposal would be important to the preservation of the target element values in the area. Areas of particular value would be all of sec 24 (the best mixed knobcone and Baker cypress), most of sec 25 and 26 (recent cypress reproduction as a result of the 1977 fire), and the remainder of secs 18 and 19 (T39N, R5E) which contain extensive, but currently unprotected cypress (see map 3 for details).

Forest Service RNA Boundaries:

The originally proposed boundaries shown in the reconnaissance report (McDonald and Rowe 1983) indicate a Forest Service RNA consisting of only about the eastern 2/3 of sec 23 (see map 3). The proposed addition of all of sec 14 and the southern half of sec 11 would more than double the area of

Baker cypress and would also administratively connect the Adobe Vernal Pools with the cypress portion of the RNA. Hence, not only would this addition be logistically wise, but ecologically sound. Only a relatively small area of non-target vegetation (eastside ponderosa pine) makes up the remainder of the proposed addition, and much of this could potentially be colonized by cypress.

I strongly recommend the establishment of the TCRNA. The natural and scientific value of both the Baker cypress and vernal pool target elements is high. With the proposed addition of the BLM and Forest Service lands discussed above, the value of the area will be greatly enhanced.

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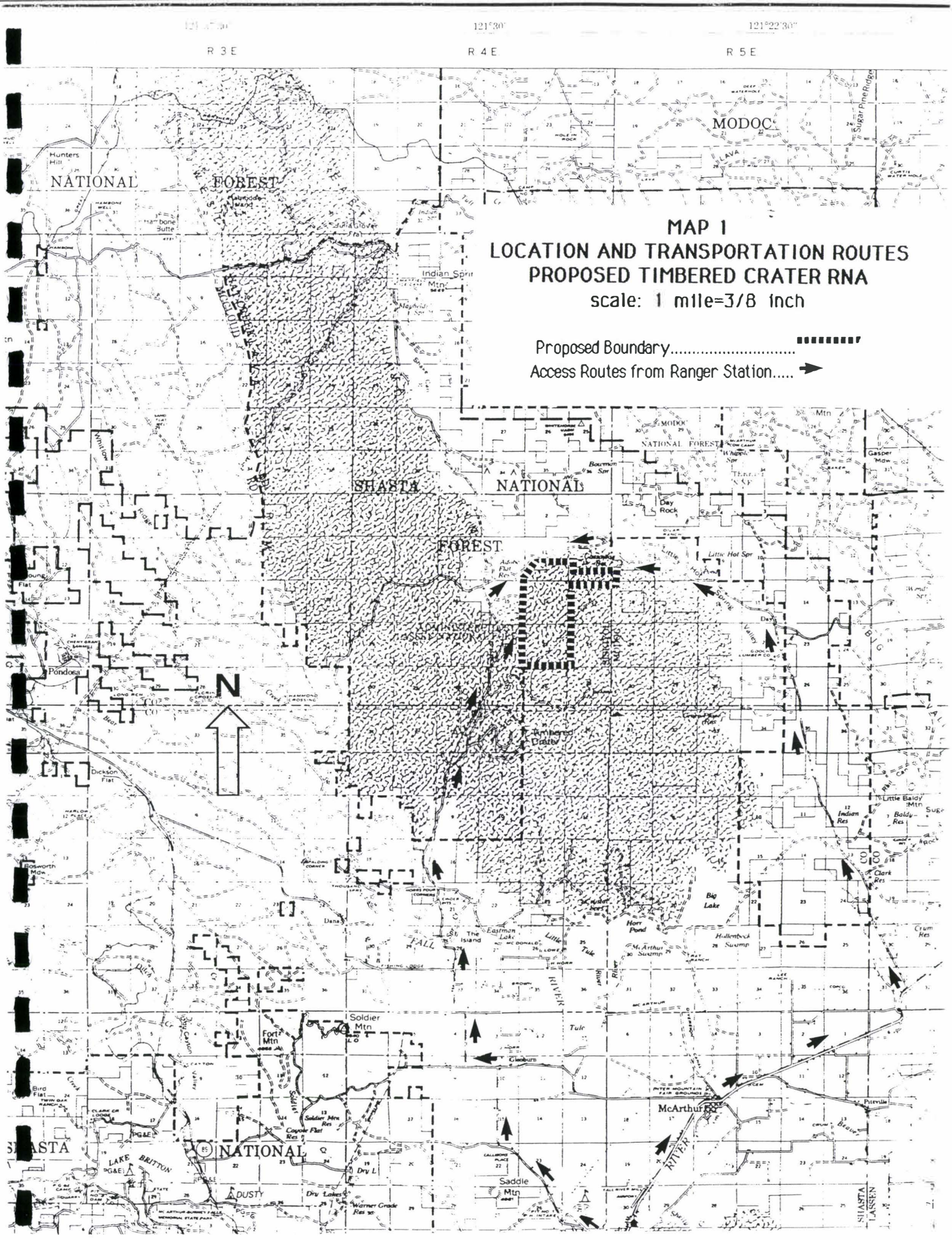
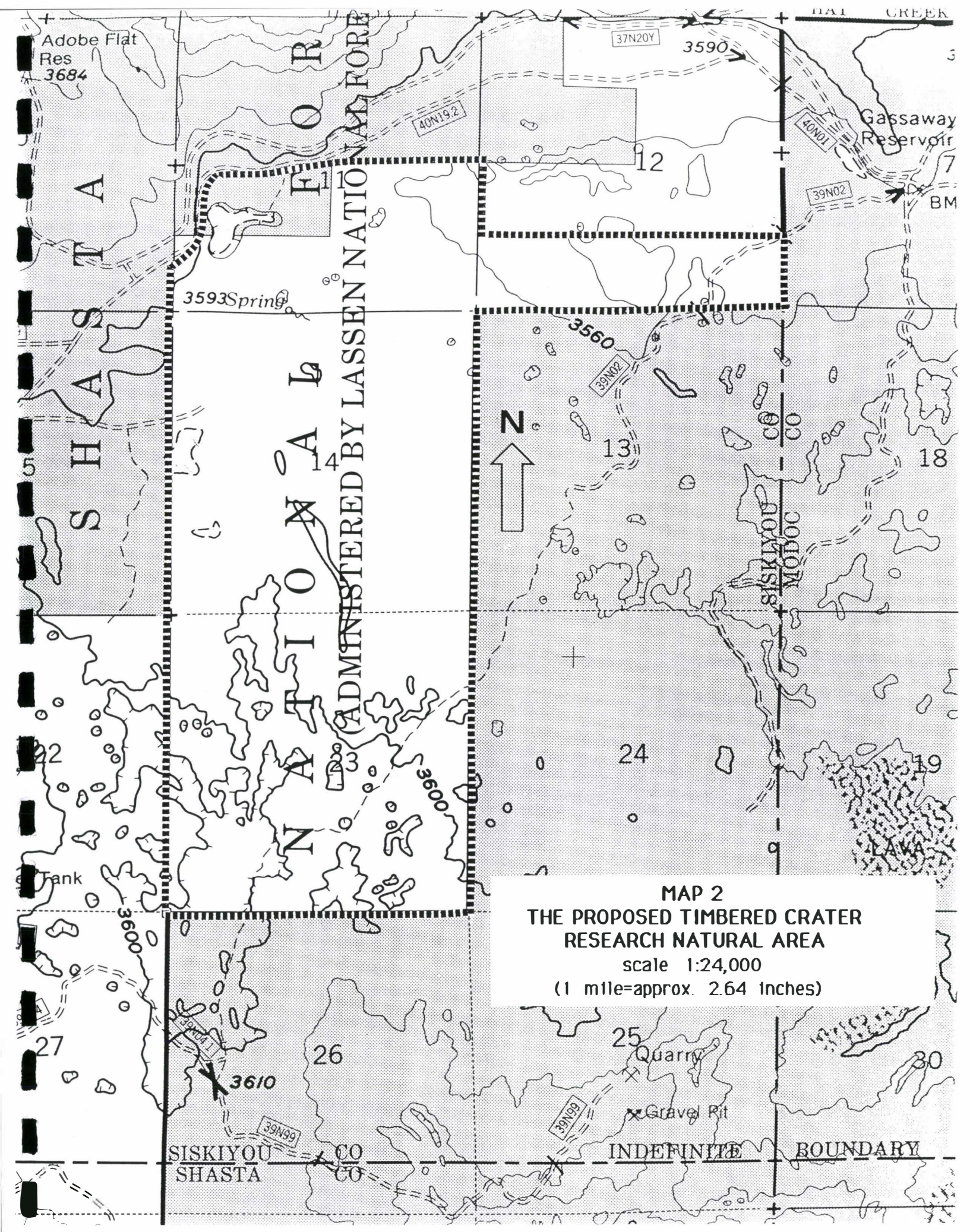
MAPS



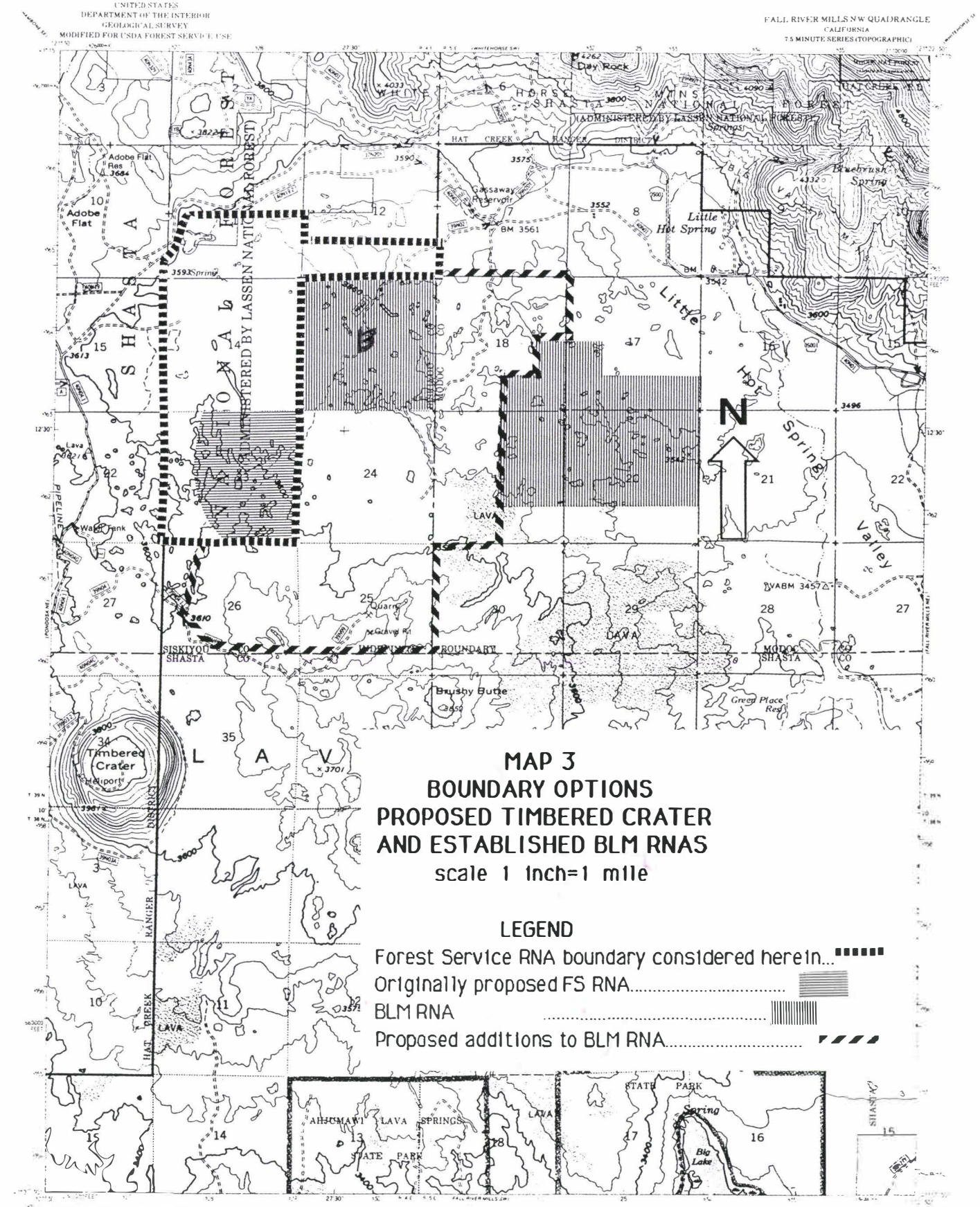
MAP 1
LOCATION AND TRANSPORTATION ROUTES
PROPOSED TIMBERED CRATER RNA
scale: 1 mile=3/8 inch

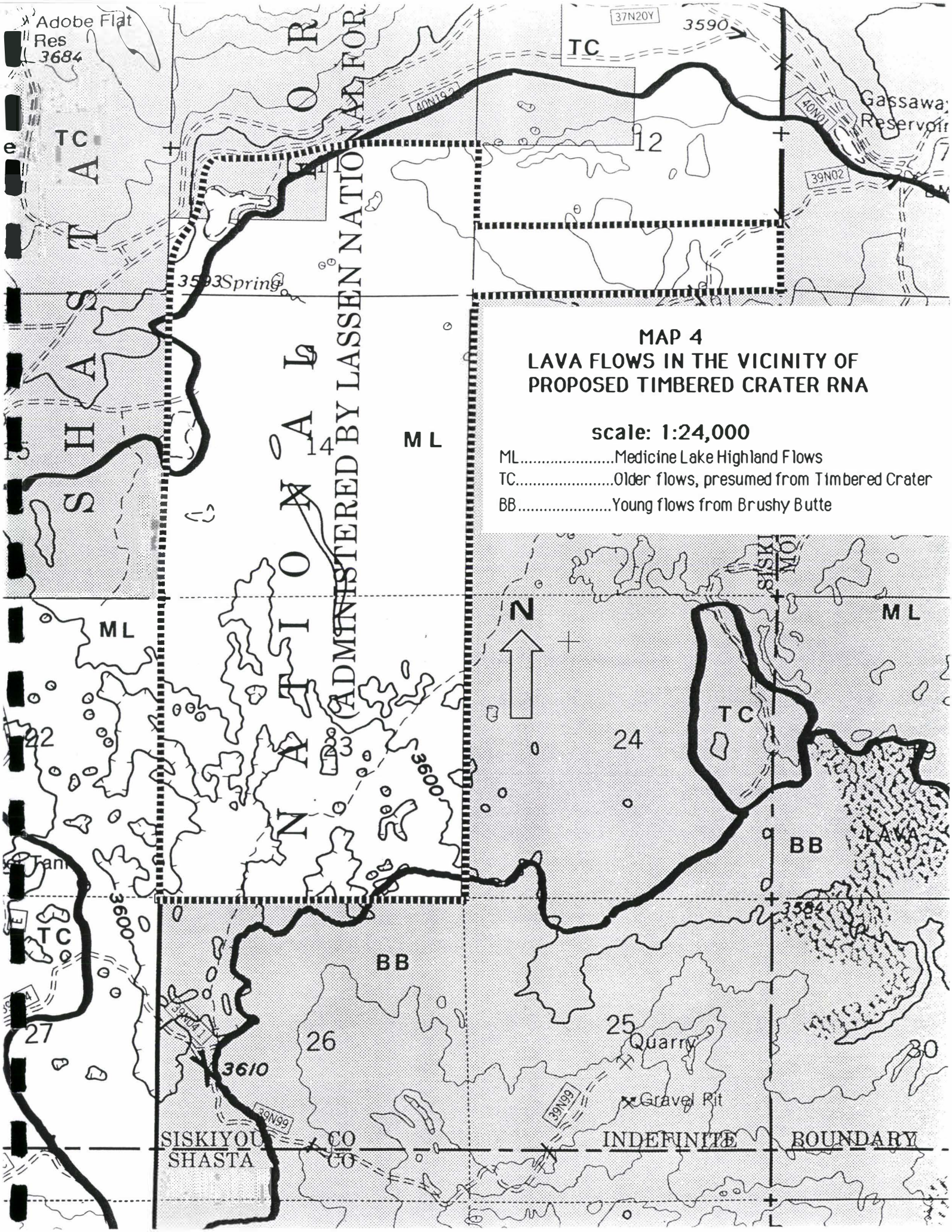
Proposed Boundary.....

Access Routes from Ranger Station..... ➔



MAP 2
THE PROPOSED TIMBERED CRATER RESEARCH NATURAL AREA
scale 1:24,000
(1 mile=approx. 2.64 inches)

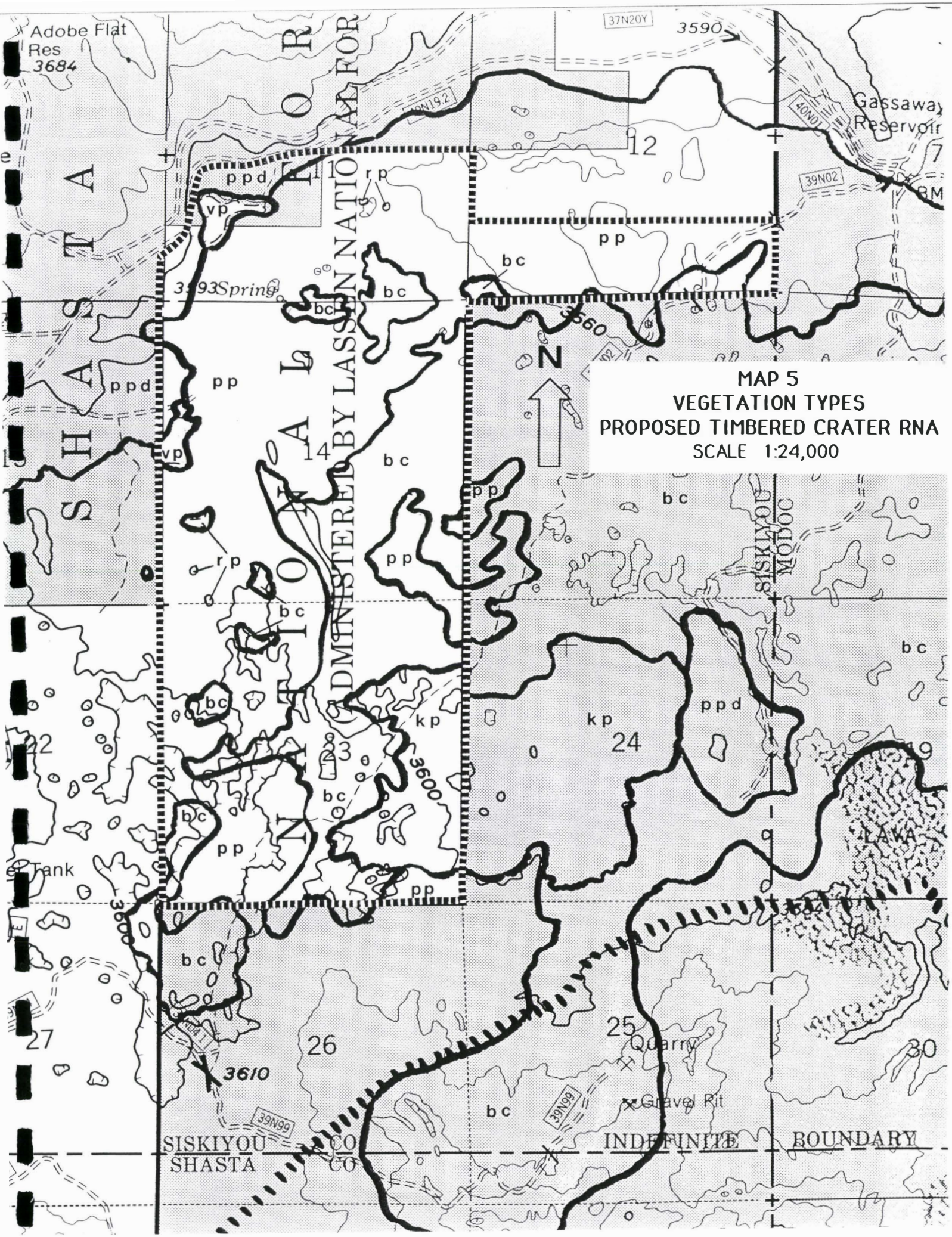

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MODIFIED FOR USDA FOREST SERVICE USE
FALL RIVER MILLS NW QUADRANGLE
CALIFORNIA
7.5 MINUTE SERIES (TOPOGRAPHIC)
MAP 3
BOUNDARY OPTIONS
PROPOSED TIMBERED CRATER
AND ESTABLISHED BLM RNAS
scale 1 inch=1 mile
LEGEND
Forest Service RNA boundary considered herein...
Originally proposed FS RNA.....
BLM RNA .....
Proposed additions to BLM RNA.....
Timbered Crater Heliport
Adobe Flat
Day Rock
Gassaway Reservoir
Little Hot Spring
Bluebrush Spring
Hot Spring Valley
Brushy Butte
Green Place Res
Lava
Water Tank
Quarry
Gravel Pit
Spring
Big Lake
STATE PARK
LAVA SPRINGS
SISKIYOU CO
SHASTA CO
MODOC CO
HAT CREEK RANGER DISTRICT
LASSEN NATIONAL FOREST
(ADMINISTERED BY LASSEN NATIONAL FOREST)
FALL RIVER MILLS NW, CALIF
678-2
REVISED 1987



MAP 4
LAVA FLOWS IN THE VICINITY OF PROPOSED TIMBERED CRATER RNA

scale: 1:24,000

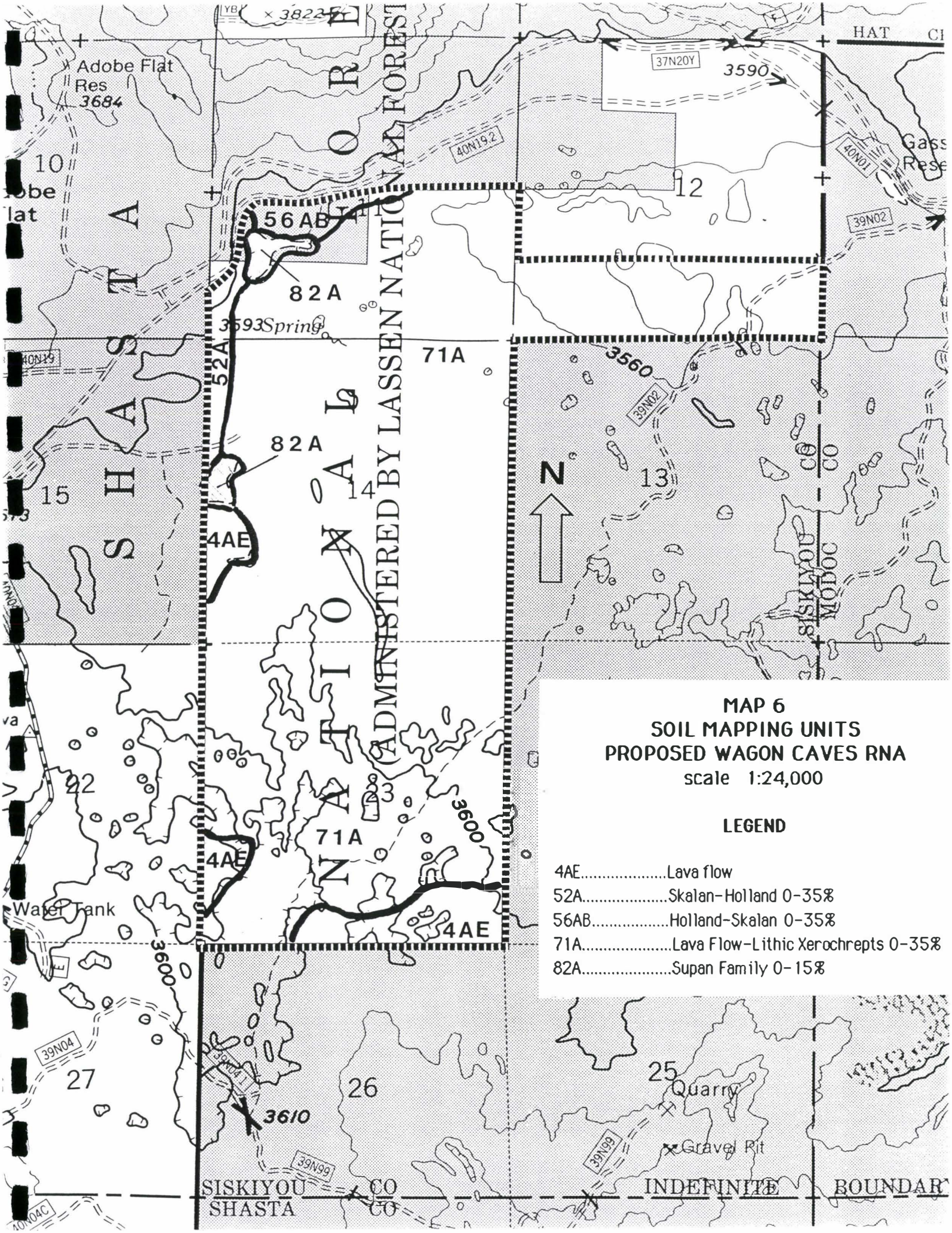
ML.....Medicine Lake Highland Flows
TC.....Older flows, presumed from Timbered Crater
BB.....Young flows from Brushy Butte


MAP 5
VEGETATION TYPES
PROPOSED TIMBERED CRATER RNA
SCALE 1:24,000
N
Adobe Flat Res 3684
Gassaway Reservoir
3590
3560
3600
3610
3593 Spring
Quarry
Gravel Pit
Tank
LAKA
SISKIYOU
MODOC
SHASTA
SISKIYOU CO
SHASTA CO
INDEFINITE BOUNDARY
ADMINISTERED BY LASSEN NATIONAL FOR
SHASTA LAKE
37N20Y
40N01
39N02
39N99
ppd
pp
vp
rp
bc
kp

LEGEND FOR VEGETATION MAP

pp.....Open eastside ponderosa pine (H 84220)
ppd.....dense eastside ponderosa pine (H 84220)
kp.....knobcone pine forest (H 83210)
bc.....Baker cypress forest (H 83220)
vp.....Northern basalt flow vernal pool (H 44131)
rp.....rocky pool (no Holland equivalent)

.....1977 fire burned south of this line



MAP 6
SOIL MAPPING UNITS
PROPOSED WAGON CAVES RNA
scale 1:24,000

LEGEND

4AE.....Lava flow
52A.....Skalan-Holland 0-35%
56AB.....Holland-Skalan 0-35%
71A.....Lava Flow-Lithic Xerochrepts 0-35%
82A.....Supan Family 0-15%

APPENDICES

APPENDIX 1
VASCULAR PLANTS NOTED FROM TIMBERED CRATER
CANDIDATE RNA

This list includes all species noted during the field work for this ecological survey from May 12 to 15, 1989. Species noted with an asterisk were identified by Gary Schoolcraft (BLM Botanist) and Beth Corbin (Lassen N.F. Botanist) at other times. This list includes 161 taxa. The following abbreviations refer to habitat types where plants were seen:

bc.....Baker cypress forest
kp.....knobcone pine forest
vp.....vernal pools
pp.....ponderosa pine forest

Agastache parvifolia ; occasional bc, kp, open pp
Agoseris heterophylla ; bc, pp, kp
Allium lemmonii ; abundant edge s vp
Alopecurus aequalis *; vp
Amelanchier pallida ; pp
Antennaria argentea ; open pp
Antennaria dimorpha ; open bc, kp
Arabis holboelii ssp. *retrofracta* ; pp open type
Arctostaphylos patula ; pp,bc,kp
Arenaria douglasii ; pp open, bc, kp
Artemisia tridentata ; vp edge
Asclepias fascicularis ; occasional edge n vp
Astragalus pulsiferae var. *suskdorfii* ; kipuka pp
Athysanus pusillus ; occasional open pp
Balsamorhiza deltoidea ; bc
Balsamorhiza hookeri ; uncommon s vp margin
Barbarea orthoceras ; vp
Blepharipappus scaber ; common open pp, bc, kp
Boisduvalia glabella ; n and s vp
Broad basal cotyledon in vp will foower in late may-June
Bromus tectorum ; pp bc, kp
Callitriche sp; large rocky pool
Calycadenia ciliosa *; vp late flowering

Calyptridium umbellatum ; pp open, bc, kp
Calystegia sp. (*polymorphus* or *occidentalis*); kipuka pp
Cardamine oligosperma ; ? only basal leaves n vp
Carex rossii ; open pp, bc, kp
Castilleja applegatei ; open pp, bc, kp
Ceanothus cuneatus ; pp, bc, kp
Ceanothus integerrimus ; occasional bc, pp open
Ceanothus prostratus ; pp
Cercis occidentalis ; kp, bc sinkhole slopes
Cercocarpus ledifolius ; bc, pp, kp
Chamaebatiaria millefolium ; occasional rocky bc, kp
Chrysothamnus nausiosus ; pp, bc
Chrysothamnus parryi ssp. *latior* ; edge of burn in bc
Chyenopodium atrovirens ?; n vp edge
Clarkia sp.; kp and edge vp
Claytonia dichotoma ; n vp
Claytonia spathulata var. *exigua* ; light shade and duff in bc, open pp, kp
Collinsia parviflora ; common open pp, bc Ususally in semi shade of plants
Comandra pallida ; open pp, bc, kp
Crepis modocensis ; occasional open pp and bc
Crypsis niliaca *; vp
Cuscuta howelliana ; common n and s vp
Cystopteris fragilis ; overhangs in lava, pp, bc
Delphinium depauperatum ; open pp, occas. bc
Delphinium nudicaule ; pp open, bc, kp
Deschampsia danthonoides ; annual vp edge s
Dichelostemma pulchella ; occasional open pp, bc
Distichlis spicata var. *nana* ; edge of rocky pool, may be first record for Siskiyou Co.
Downingia bacigalupii *; vp
Downingia bicornuta ; common at n vp
Downingia cuspidata ; common at s vp
Draba verna ; open pp, bc, margin vp
Epilobium minutum ; open pp, bc
Eremocarpus setigerus *; vp
Erigeron eatonii ssp. *plantigineus* ; edge vp common
Erigeron inornatus ; pp open
Erigeron pumilis ssp. *intermedius* ; exposed lava open pp, bc
Eriogonum marifolium ; open pp, bc, kp

Eriogonum nudum ; pp, bc,
Eriogonum umbellatum var *polyanthum* ; common bc, open pp
Eriophyllum lanatum ssp.; pp open
Eryngium alismaefolium ; vp and moist meadow
Eryngium mathiasiae ; vp and large rocky pool
Erysimum capitatum ; pp open, bc
Festuca idahoensis ; bc, kp, open pp
Fraxinus latifolia ; edges of s vp, big rocky pool
Fritillaria recurva ; bc, open pp, kp
Galium asperrimum; common in open pp and bc
Gnaphalium palustre ; not in flower n vp
Gratiola ebracteata ; n vp common
Grindelia camporum ; common, late flowering at n vp
Helocharis palustris ; abundant deeper vp and rocky pool
Heleocharis sp; smaller plant than previous, at n vp not in flower in May
Hesperochiron pumilis ; border of s vp under Ceanothus cuneatus
Heterocodon rariflorum ; edge of rocky pool
Holodiscus boursieri ; new lava, pp, bc
Horkelia tridentata ; open pp, bc, kp
Idahoa scapigera ; open pp, bc
Isoetes howellii ; large rocky pool
Juniperus occidentalis ssp. occidentalis ; pp open, occasional bc
Lasthenia sp?; basal leaves only s vp
Leptodactylon pungens ; open pp, bc, kp
Linanthus bakeri ; open pp, bc, kp common
Linanthus ciliatus ; pp
Lithophragma parviflorum ; open pp, bc
Lomatium dissectum ; crevices in lava open pp, bc
Lomatium nevadense ; open pp, bc, kp
Lomatium nudicaule ; open pp, bc
Lomatium (piperi) ?; clay margins of s vp
Lonicera sp. ; pp and vernal pool ecotone
Lotus sp.; basal leaves in pp
Lotus sp.; tiny annual w/ 3-foliate villious leaves, edge rocky pool
Lotus purshianus *; vp
Lupinus andersonii; kipuka of pp on e side
Lupinus caudatus ; open pp
Lythrum hyssopifolia ; vp
Machaeocarpus californicus ; n vp not common

Madia minima ; pp, bc, kp
Microsteris gracilis ; occasional in open pp, bc
Microsteris natans ?; kp,bc
Mimulus breviflorus ; common yellow on open pp, bc, kp
Mimulus moschatus ; edge of big rocky pool
Mimulus nanus ; common purple; open pp, bc, kp
Mimulus tricolor ; vp
Myosurus minimus ssp.?; vp
Nama lobbii ; edge of burn in bc
Navarretia divaricata ; glandular, edge of s vp
Navarretia minima ; abundant both vp
Orcuttia tenuis ; new leaves at scraped pit in n vp
Orthocarpus campestris ; s vp
Penstemon deustus ssp. *heterander;* open pp, bc, kp
Penstemon speciosus ; white margined leaves, pp kipuka
Perideridia sp.; vp edge s
Phacelia mutabilis ; open pp, bc
Phoradendron bolleanum ; bc, and on w juniper
Plagiobothrys bracteatus ; vp n
Plagiobothrys tenellus ; common on dry lava flats pp bc, kp
Plectritis samolifolia var. *involuta* ; semi shade of pp and bc
Poa bulbosa ; old flow pp/vp ecotone
*Poa canbyi (*or *sandburgii)* ?; puburlent lower lemma, contracted panicle, open pp, bc
Poa fendleriana ; common perennial of open pp, bc, kp long hairy lemma margins
Pogogyne zizyphoroides ; vp
Polemoniaceae sp; tiny Githopsis type edge rocky pool
Polygala cornuta ; bc uncommon
Polygonum amphibium var. *stipulaceum* ; deeper water of vp
Polygonum douglasii var. *johnstonii* ; tiny annual common in vp
Polygonum minimum ssp. *esotericum* ?; common in one part of n vp but only old ones so cant be sure
Potentilla glandulosa; edge rocky pool
Prunus emarginatus ; pp, rocky bc
Prunus virginianus var. *menanocarpa* ; common in recent lava and occasional in bc, pp
Psilocarphus brevissimus ; common n and s vp
Purshia tridentata ; pp, bc, kp
Quercus garryana ; scrubby trees in bc, larger trees in pp and vp edges

Quercus kelloggii ; occasional in old flow pp
Ranunculus aquatalis var. *hispidulus* ; vp
Ranunculus occidentalis ; vp
Rhamnus californica ; deciduous, pp, open
Rhus trilobata ; pp, vp edge
Ribes cereum ; bc uncommon
Rosa californica; edge of vp
Rubus leucodermis ; fissures in bc
Salix sp.; edge of small rocky pools
Sambucus caerulea ; bc, kp
Sanguisorba occidentalis ; n vp edge
Sanicula nevadensis ; open bc
Senecio eurycephalus ; cut leaved sp. of open pp and bc
Senecio integerrimus ; pp old flow
Sidalcea oregana ; deeper soils in open pp
Streptanthus tortuosus ; open lava new, Brushy Butte
Thermopsis macrophylla var. *argentata;* edge vp and old pp
Thysanocarpus curvipes ; open pp, bc
Vicia californica ; occasional bc, open pp
Viola lobata ; pp (old flow)
Viola purpurea ssp. *dimorpha* ; bc, open pp, kp
Vulpia reflexa ; common in bc, kp
Wyethia angustifolia ; pp kipuka
Wyethia mollis ; pp kipuka
Zigadenus paniculatus ; pp open, bc

APPENDIX 2

VERTEBRATES NOTED FROM THE TIMBERED CRATER
CANDIDATE RNA

Amphibians and Reptiles (after Stebbins 1985):
Southern long-toed salamander; larvae common in n vernal pool in early May
Western toad; adults and larvae, southern vp
Pacific tree frog; both vp and large rocky pool
Sagebrush lizard; open pp, bc, lava outcrops
Western terrestrial garter snake; common at large rocky pool

Birds (common names after Robbins et al. 1983):
Osprey; flying over eastern side of area toward little Hot Springs Valley
Red-tailed hawk; widespread overhead
Cooper's hawk; open pp, bc
Turkey vulture; open pp overhead
Wood duck; n vernal pool
Canada goose; several s vp
Mallard; several s vp and large rocky pool
California quail; only seen in buckbrush near s vp
Mountain quail; more common than California, pp, bc, kp
Spotted sandpiper; s vp
Killdeer; s vp
Mourning dove; edge both vp
Anna's hummingbird; open pp, bc
Poorwill; edge of s vp
Lewis' woodpecker; edge of bc/burned area
Hairy woodpecker; open pp, bc
White-headed woodpecker; open pp
Common flicker; open pp, bc
Ash-throated flycatcher; open pp, bc
Western kingbird; burned area
Western wood pewee; edge vp and open pp
Olive-sided flycatcher; old flow pp
White-breasted nuthatch; pp, bc kp
Pygmy nuthatch; open pp, bc, kp
Red-breasted nuthatch; open pp, bc
Plain titmouse; open pp, bc

Bushtit; open pp, bc
Mountain chickadee; closed and open pp, bc, kp
Bewick's wren; dense kp, bc
Steller's jay; open pp, bc, old flow pp
Common raven; pp, bc, kp
Solitary vireo; kp, bc
Nashville warbler; open pp, bc
Black-throated gray warbler; kp, bc
Yellow-rumped warbler; pp
Brewer's blackbird; common s vp
Brown-headed cowbird; common in open pp, bc, and edge of vp
Western tanager; open pp
Lazuli bunting; burned bc, mtn chaparral
Dark-eyed junco; pp, bc, vp edge
Purple finch; open pp, bc, old flow pp
Black-headed grosbeak; old flow pp, occasional bc
Fox sparrow; open bc, pp
Rufous-sided towhee; brushy thickets bc, pp, most abundant bird of open forests

Mammals (after Jameson and Peeters 1988):
Broad-handed mole; ridges in open bc
Shadow chipmunk; open and closed pp, bc
Gray Squirrel; old flow pp forest with oaks near n vp
Beechey ground squirrel; open pp and edges of vp
Bushy-tailed woodrat; middens in pp and bc lava areas
Dusky-footed woodrat: possibly this species responsible for middens in dense Baker cypress stands, etc.
Audubon's cottontail; edge of s vp, kp
Black-tailed hare; open edge of s vp
Elk; droppings near s vp and in open pp
Mule deer; vp, pp, bc
Black bear; wallows and footprints in vp
Coyote; heard, and prints and sign seen

PHOTO CAPTIONS

Photo 1: Well-developed mixed forest of knobcone pine and Baker cypress in the SE 1/4 sec. 23.

Photo 2: Open eastside ponderosa pine forest in the NW 1/4 sec. 23. Understory dominated by greenleaf manzanita and buckbrush.

Photo 3: A dense band of *Thermopsis macrophylla* var. *argentata* (CNPS list 4) at the western edge of the northern vernal pool.

Photo 4: *Balsamorhiza hookeri* and *Erigeron eatonii* ssp. *plantigineus* on the sub-alkaline outer border of the southern vernal pool.

Photo 5: A dense aggregation of *Allium lemmonii* along the northeastern margin of the southern vernal pool.

Photo 6: A locally dense aggregation of *Pogogyne zizyphoroides* with *Navarretia minima, Eryngium mathiasiae,* and *Plagiobothrus bracteatus* on the moist rim of the northern vernal pool.

Photo 7: *Downingia bicornuta* at the northern vernal pool (with basal leaves of *Eryngium mathiasiae*).

Photo 8: *Mimulus tricolor* at the northern vernal pool.

Photo 9: View looking northeast across a portion of the southern vernal pool showing characteristic flat boulders associated with the main pool.

Photo 10: Open ponderosa pine forest of the mid-portion of sec. 14 with scattered western juniper and Oregon oak.

Photo 11: The anomalous stand of open ponderosa pine with incense-cedar and Oregon oak on Recent lava in SE 1/4 sec. 23. Herb in foreground is *Lomatium dissectum* , characteristic of rough lava flows.

Photo 12: Detail of understory in open ponderosa pine forest showing relatively high cover and diversity of herbaceous vegetation.

Photo 13: View looking east across northern vernal pool showing adjacent

dense ponderosa pine forest on Pleistocene basalt. Note well developed multiple-stemmed Oregon oak in right foreground.

Photo 14: Baker cypress stand associated with raised lava ridge on the Medicine Lake Highland flows, NE 1/4 sec. 23.

Photo 15: Approximately 12 year old Baker cypress with cone cluster dating back to wet years of 1982-83. This individual is ca. 4 ft. (1.2 m) tall.

Photo 16: Tall Baker cypress at bottom of sinkhole NE 1/4 sec. 14, individual in center is ca. 70 ft. (21 m) tall.

Photo 17: Picturesque Baker cypress with *Letharia* and *Bryoria* lichens festooning branches, typical of open stands at edges of lava flats.

Photo 18: Recent reproduction of Baker cypress averaging 2-3 ft. (60-90 cm) in height along the road to the quarry in the SW 1/4 sec. 25.

Photo 19: Looking east across the large rocky pool in the SW 1/4 sec 14. Dominant species in the pool is *Heleocharis palustris*, shrub along bank in foreground is *Fraxinus latifolia*.

Photo 20: Small rocky pool at bottom of sinkhole in SW 1/4 sec. 12. Open ponderosa pine forest in background.

Photo 21: Long-toed salamander larvae collected from northern vernal pool.

Photo 22: Very rough Recent lava from Brushy Butte in SE 1/4 Sec. 23. Small shrub in foreground is *Chamaebatiaria millefolium*, note dense Baker cypress stand in background at edge of flow.

Photo 1

Photo 2

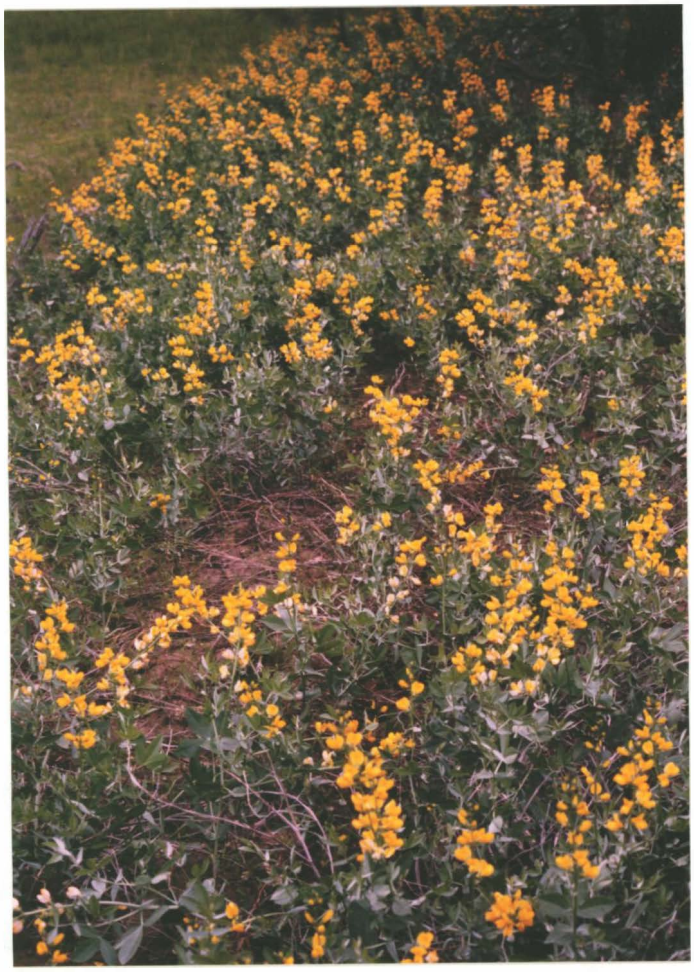


Photo 3

Photo 4

Photo 5

Photo 6

Photo 9

Photo 10

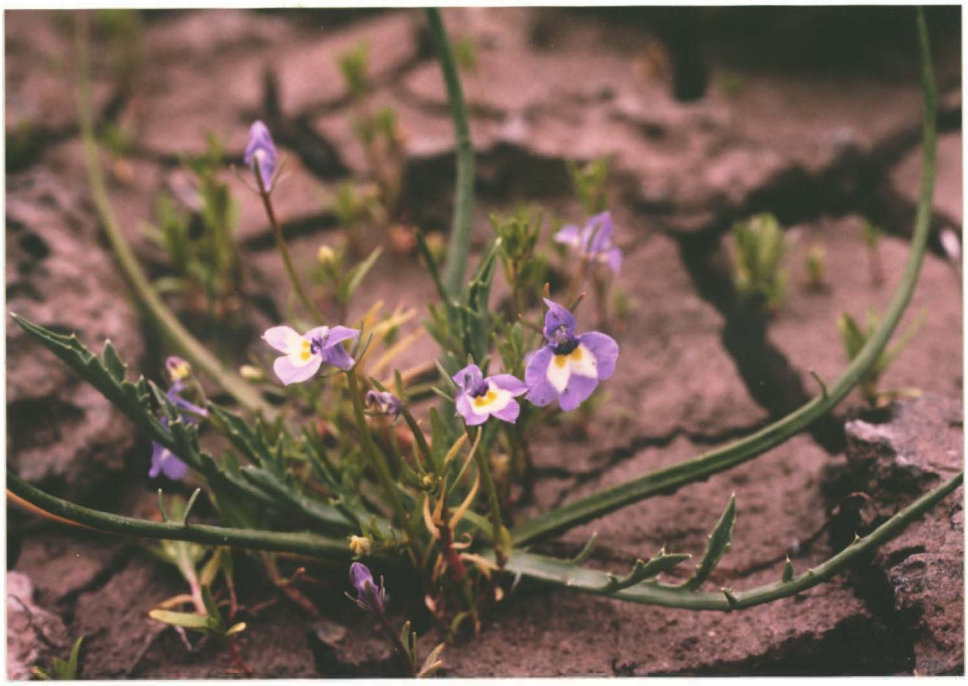


Photo 7

Photo 8

Photo 11

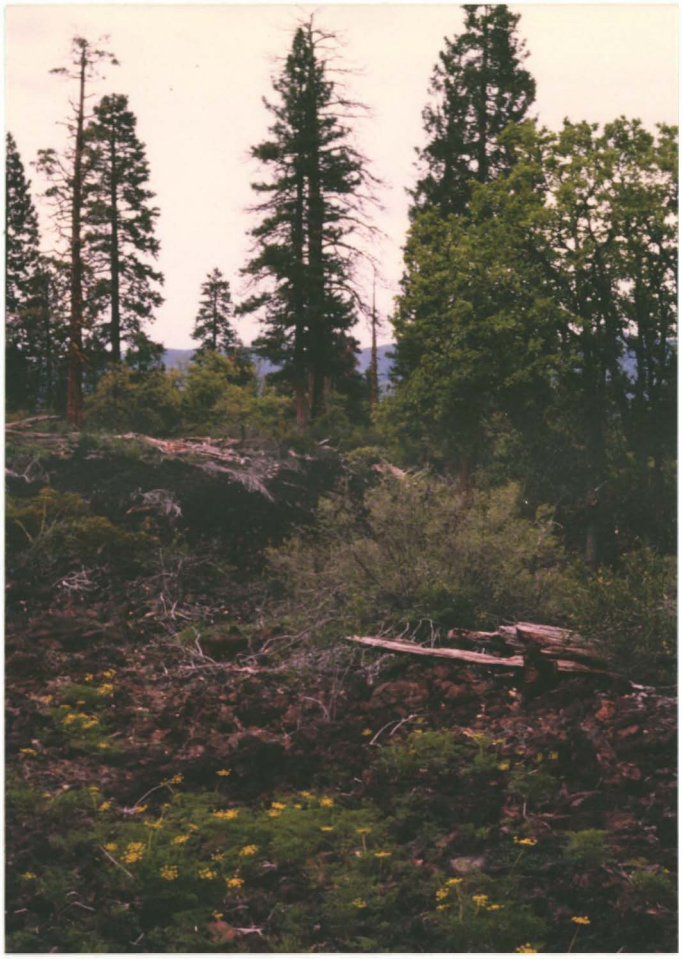


Photo 12

Photo 13

Photo 14

Photo 15

Photo 16

Photo 17

Photo 18

Photo 19

Photo 20

Photo 21

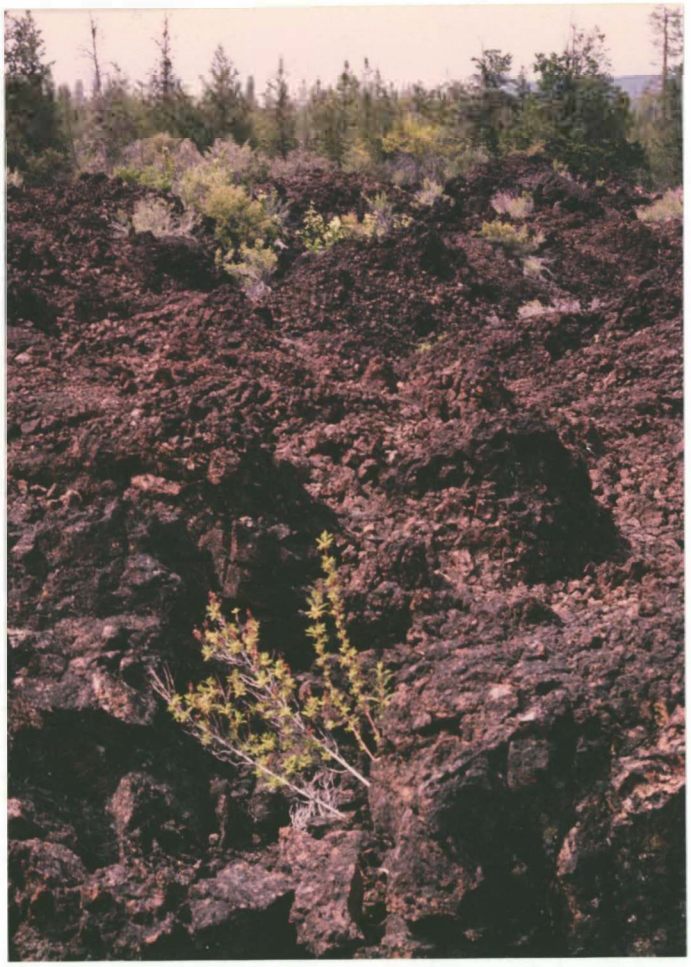


Photo 22

DATE DUE

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KEELER-WOLF

Ecological Survey of the Proposed Timbered Crater Research Natural Area Lassen National Forest, Siskiyou County, California.

DATE	ISSUED TO

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